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EDITORIAL.

Manuring of Inland Soils.

In the *Malayan Agricultural Journal* issued in August of this year an article on the classification and properties of Malayan soils, by Mr. J. H. Dennett, was published. The article was prefaced by an Introduction by Dr. H. A. Tempany in which it was stated that it was intended to publish in this Journal a series of articles dealing with Malayan soils. Mr. Dennett's article formed the first contribution to the series now continued in a second article by Mr. W. N. C. Belgrave entitled "Preliminary Observations on Manuring of Annuals on Inland Soils", which appears in the present number.

The information contained in this article relates to inland soils and to annual crops, with regard to which there has been, up to now, less published information available than is the case with the permanent crops such as rubber, coconuts and oil palms concerning which results of manurial experiments have been published, in this and other local Journals, from time to time. Manurial experiments with the main annual crop *i.e.* rice, have also been published but the use of manures in the cultivation of rice is of necessity a specialised subject already discussed in this Journal and does not come into the scope of the present article which is concerned with annual crops grown on non-irrigated soils. Manuring in general on coastal soils, which are mainly heavy clays and organic soils, is also a subject which must be dealt with separately.

The cultivation of annual crops presents difficulties that do not arise in the cultivation of permanent crops, and it is certain that if successive annual crops, are to be obtained from an area of land, in any country, the question of manuring is of primary importance, and this applies particularly to tropical soils, newly opened up from jungle. Such soils may become rapidly infertile if nothing is done to replace the nutrient material which is removed from the soil by annual crops.

Under jungle, and to a certain extent under the conditions obtaining with permanent crops, soil is not rapidly denuded of nutrients, by reason of the fact that jungle and permanent crops such as trees and shrubs normally remove plant food from the soil at a rate which is counterbalanced to a large extent by the breaking down process, whereby the greater part of the plant food absorbed is later returned to the soil.

This process is always in operation under jungle conditions and cannot operate to the anything like the same extent in soil where a considerable proportion of the plant food is removed in the crop and is not naturally returned to the soil.

Under such conditions the use of artificial methods of replacement of nutrients is imperative and the problem in its many complex aspects, is discussed in the article now published.

It is evident that, the question of cost must be taken into consideration since it is naturally impossible to continue to employ various manures either in the form of green manures, cattle manure, or artificial fertilisers, if the cost of the operations is not justified by economic increase in the yields obtained. In this connection the advantages of using the cheapest form of manure is at once apparent, but here again the question of efficiency must be considered. Cheapness is an essential requirement in the economical employment of manures on crops from which the monetary return is not large, especially under present conditions of low prices for every agricultural commodity.

The question of the economics of manuring of annual crops is discussed in the present article and it is considered that if cheap manures prove to be ineffective, large scale cultivation of annual crops, other than wet padi, may have to be ruled out from the programme of general agricultural development on the greater part of the very old, heavily leached, inland soils of Malaya.

The third paper in this series, dealing with the question of organic matter and nitrogen in Malayan soils will be published in the *Malayan Agricultural Journal* in the near future.

Bleaching of Palm Oil.

In a previous number of this Journal* (January 1933) a comprehensive account was given of the various methods employed for bleaching palm oil.

The investigation has now been carried one stage further, one of the methods having now been developed on a semi-commercial scale.

In the article included in the present number entitled "Bleaching of Palm Oil at Serdang" Messrs C. D. V. Georgi and T. D. Marsh describe the method of air-bleaching the oil, using a catalyst.

The process is simple, no expensive plant is required, and the method gives satisfactory results. It is hoped, therefore, that those who are interested in the possibilities of bleached palm oil will avail themselves of the invitation to witness a demonstration of the process.

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* *Malayan Agricultural Journal*, Vol. XXI, No. 1, January 1933.

The Malayan Pineapple Industry.

During the past few years, considerable attention has been paid to the question of the improvement of the pineapple industry in Malaya. The efforts, particularly of the Malayan Information Agency in London, to popularise Malayan tinned pineapples in Great Britain along with propaganda on the continents of Europe and America at Exhibitions and World Fairs, have been recorded from time to time in this Journal and in local newspapers. It is largely due to the success which has attended these efforts that the market for Malayan pineapples has been maintained and extended, despite competition from other producing countries.

It is not improbable, however, that the prosperity of the industry in Malaya will in the future depend largely on local efforts aiming at the improvement of the quality of the canned product. Attention is now being given to this matter not only from the commercial and manufacturing aspects, but also from the agricultural side of the question.

Reference has recently been made to the desirability of extending pineapple cultivation as a main crop. This should help to ensure a more constant supply of fruit suitable for canning. The majority of the fruit supplied to the canneries still comes from scattered areas where the crop is grown as a catch crop with rubber or is interplanted with other crops on small holdings. Recently, however, a move has been made in several centres, mainly in Johore and Selangor, to cultivate pineapples as a sole crop, and already an area of approximately 10,000 acres is under this type of cultivation.

Experimental work on pineapples has been in progress for some years, at the Agricultural Experiment Station, situated near Singapore town, where information is being collected and analysed partly with a view to estimating the manurial requirements of pineapples grown year by year as a sole crop on the same land. The land on which the experiments have been conducted is not fertile land newly opened up from jungle, but is land of poor fertility, on which pineapples had previously been grown for several years.

The results of the manurial experiments conducted on the Station, during the period June 1932 to March 1933 when the first crop was harvested, are given in the article, by Mr. G. D. P. Olds, which is published in the present number of the Journal. The results are encouraging and have provided considerable information which can be used as a guide to future experimental work, and, although it would be unwise to draw definite conclusions at this early stage of the work, it appears highly probable that methods of improving and maintaining the fertility of soil devoted to pineapple cultivation in this country, can be evolved.

Whether the methods will prove to be economic or not depends largely on the price received for the product. Prices are at present low and, mainly on account of the methods adopted in marketing whereby the industry as a whole is penalised on account of the lack of standard grades for export, there does not appear to be a likelihood of obtaining enhanced prices until the business side of the industry is better organised.

Malayan pines have a monopoly at present, of the English market, but this is being threatened by potential competition from other countries and it is very essential that the efforts now being made to effect improvements in every branch of the industry should be maintained.

Original Articles.

STUDIES IN MALAYAN SOILS.

Part II. Preliminary Observations on Manuring of Annuals on Inland Soils.

BY

W. N. C. BELGRAVE,

Chief Research Officer.

The following article deals exclusively with the commonest types of non-irrigated inland soils; inundated soils are excluded, manurial experiments with wet padi having already been described in detail in this Journal.*

Discussion of the history and composition of Malayan soils in Part I has indicated that the most generally distributed inland soil types—*viz.* quartzite, Raub and granite may be expected to be poor in nutrient material.

There is however a deeply-rooted local belief that Malayan soils are exceptionally fertile and need no manuring. Like so many popular beliefs this one rests on perfectly correct observations but on a faulty deduction. The correct observations are the luxuriance of wild vegetation (primeval or secondary jungle shrubs) and the successful growth for long periods without manuring of rubber, coconuts and wet padi. The faulty deduction is the assumption that richness of soil is an absolute instead of a relative quality. When the growth of annuals (garden or crop plants) or lawn grass is attempted under dry (non-inundated) conditions, the fallacy is exposed.

In the writer's view the explanation of the differences between the growth of annuals and trees or shrubs depends on the very different rates of absorption of nutrients shown by these plants.

The quantity of nutrients available for absorption by plants at any instant is low in any soil and particularly low in Malayan soils; processes of breakdown, however, are in continuous operation and tend to renew the available food as fast as it is absorbed. If absorption proceeds faster than breakdown the plant will starve; if the processes balance, growth, other factors being favourable, should be satisfactory. At first sight it may appear that demands by trees and shrubs greatly exceed those made by annuals, but it must be remembered that it is not total absorption but rate of absorption which must be compared with breakdown. A tree has a large volume of soil to feed on and, probably, in Malaya with its steady rainfall and temperature has the whole year in which to do it, the annual may have relatively a far smaller volume of soil and certainly has much less time available, therefore the rate per unit volume of soil of the first may be low, of the second high. A supply of nutrients sufficient for growth of the tree may then fall far short of that necessary for the annual.

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* *Malayan Agricultural Journal*, Vol. 19, page 587, 1931; Vol. 20, page 631, 1932.

To prove this theory would require a prohibitive amount of work, but support may be obtained for it by comparing the rate of growth of tree seedlings with that of annuals of corresponding size such as maize or ragi. The great outbursts of activity in leaf formation, exhibited by trees or shrubs after 'wintering' or pruning, take place at the expense of reserves stored in the plant, not as the result of absorption of food from the soil at the time of flushing, and cannot therefore be quoted in support of high absorption rates.

This discussion should not be taken as implying that manures are unnecessary for crop production from trees or shrubs. Successful vegetative growth does not exclude the possibility of crop enhancement by manures.

Whether the theory outlined is true or false it is a fact that for the successful growth of annual crops, except on virgin soil, manuring is essential; if, however, the correct manures are applied, it may be predicted that satisfactory results should follow as the texture of the majority of our inland soils is excellent. Unfortunately low prices of many crop products may render manuring uneconomic in spite of considerable crop increase.

Manures.

The plant foods most likely to be deficient are nitrogen, phosphorus and potash. On special types of soil there may also be deficiency of iron, magnesium, manganese, sulphur and of other elements, but these may be neglected in in a general discussion, and the supply of the three elements first named alone considered.

Manures may be divided into two broad classes, those generally manufactured or grown by the agriculturist and those purchased—artificial fertilisers. The former class comprises animal manure, composts and green manure, the latter the whole range of commercial mineral and organic fertilisers.

Natural Manures.

(*a*) *Cattle manure.* Where animals play an important part in agriculture, their dung is the most important source of manure; owing to the large quantity of organic debris incorporated from litter well prepared farmyard manure improves the texture of many soils and provides material for biological activity, in addition to the primary duty of adding large quantities of nitrogen, phosphorus and potash. Unfortunately animal husbandry is not an integral part of Malayan agriculture and the quality of manure made from the comparatively small number of penned animals leaves much to be desired. Urine is usually allowed to escape and the manure frequently contains a high proportion of soil.

(*b*) *Composts.* Comparatively recently, composts of vegetable debris in which decomposition is assisted by addition of urine, mineral salts or the patent preparation ADCO have come into prominence elsewhere as substitutes for cattle manure; work to be detailed in Part III of this series of studies does not suggest that they are likely to be more valuable than green manure in Malaya.

(*c*) *Green manures.* Except for such nitrogen as may be fixed from the air by bacteria in the root nodules of leguminous plants, green manures add nothing to the total plant food of the soil but should on decomposition considerably increase the available food. Both composts and green manures like cattle manure are bulky and should usefully stimulate biological activity.

Experience in other countries with all natural manures and especialy with green manures is that they should either be well rotted before application (animal manure and composts) or turned in sufficiently long before planting to permit of rotting in the soil. If this is not done injury to young plants may result from reduction of available (as opposed to total) nitrogen owing to intense biological activity with resultant locking up of nitrogen in unavailable form in the bodies of bacteria and fungi.

Another possible benefit, which however is the subject of considerable dispute, is improvement of the plant by enhancement of carbon dioxide given off in the process of decomposition.

(*d*) *Commercial fertilisers.* Price is naturally a prime, although not the only, consideration in purchasing manures and the accepted method of comparing prices is to calculate the price of one unit of plant food, taking the unit as one-hundredth of a ton, *i.e.* the price of manure per ton is divided by the percentage of nutrient contained. Once standards have been established for each nutrient from manures the value of mixed manures can be calculated by multiplying unit values by the percentage of each nutrient present and summing the result.

Table A shows some properties and unit prices of the commoner fertilisers on sale in Malaya. The large margin between home and local prices of the very important manures, super and basic slag, is curious. The column headed 'reaction in soil' may refer either to direct action due to composition or to indirect action due to changes after application, the alkalinity of cyanamide or basic slag is of the former, the acidity of sulphate of ammonia of the latter class.

Full justice has not been done to some of the fertilisers in Table A, *e.g.* cyanamide and basis slag contain approximately 20% of lime (or of substances reacting as lime in the soil) which, at a local price of $20 per ton for lime, adds $4 to their value per ton and reduces the unit value of nitrogen and phosphoric acid quoted. Similarly the meals contain small quantities of phosphoric acid and potash.

Table A.

Manures supplying single nutrients.

	Nutrient per cent. N‡	P_2O_5	K_2O	Solubility in water	Reaction in Soil	Price* per unit local f.o.r.	Price† per unit in U.K.
A. **Inorganic**							
Nitrogenous							
Sulphate of Ammonia	20	—	—	Soluble	Acid	$3.10	$2.70 c.i.f.
Calcium cyanamide	19	—	—	Insoluble	Alkaline	3.70	3.00 c.i.f.
Nitrate of soda	15	—	—	Soluble	Alkaline	8.30	4.86 c.i.f.
Urea	46	—	—	Soluble	Neutral	5.20	—
Phosphatic							
Superphosphate single	—	18	—	Partly Soluble	Acid	3.00	1.50 f.o.r. (14 per cent.)
Superphosphate concd.	—	39	—	do.	do.	2.00	—
Basic slag	—	16	—	Insoluble	Alkaline	3.70	1.70 c.i.f. (14 per cent.)
Rock phosphate	—	26	—	do.	Neutral or Alkaline	1.70	0.70 c.i.f.
Local phosphate ‖	6	28	—	do.	Neutral	varies	—
Potassic							
Muriate of Potash	—	—	50	Soluble	Neutral or Acid	2.50	1.80
Sulphate of Potash	—	—	48	do.	do.	2.30	2.20
Kainit (supplies magnesium also)	—	—	20	do.	do.	3.50	2.10
B. **Organic**							
Nitrogenous							
Blood meal	11	—	—	Insoluble	?	14.50	5.50§
Castor cake meal	4	—	—	do.	?	17.50	—
Ground cake meal	7	—	—	do.	?	11.40	—
Oil Cakes (approx.)							6.00§

* Prices to the nearest 10 cents exclusive of Railway freight in 1933.

† Prices to the nearest 10 cents in "Fertiliser" for April 26, 1933.

‡ N, P_2O_5 and K_2O designate nitrogen, phosphoric anhydride (often called phosphoric acid) and potash respectively.

‖ Often called guano. In the majority of cases the quantity of nitrogen is negligible.

§ Prices given in "A Note Book of Tropical Agriculture" by R. C. Wood, 1933.

Fertilisers supplying more than one constituent.

The best known of these are the "ammonium phosphates", whale guano and bone meal. Ammonium phosphates are synthetic water-soluble bodies consisting of mixture of ammonium sulphate and ammonium phosphates in varying proportion and sold under trade names such as Ammophos (U.S.A.), Leunaphos (Germany) and Niciphos (G.B.). Taking two grades of the last named and unit values for N and P_2O_5 found from ammonium sulphate and concentrated superphosphate in Table A, calculated and actual values per ton f.o.r. are —

	per cent.	per cent.	Calculated value per ton	Local price
Niciphos A	N 14	P_2O_5 43	$129.40	$134.00
,, B	18	18	91.80	114.50

Complete inorganic mixtures such as the Enpekay series give the following figures —

	per cent.	per cent.	per cent.	$	$
Enpekay No. 1	N 12.5	P_2O_5 12.5	K_2O 15	98.50	125.00
5	8	21.5	16	104.50	122.00

The best known non-proprietary organic manure supplying two nutrients is whale guano, containing 7 per cent. N and 8 per cent. P_2O_5 selling locally at $140 per ton; adopting the ground-nut nitrogen unit value of $11.43 from Table A, the unit value of P_2O_5 in this manure is $7.50. Adopting the inorganic standards used above 1 ton would be worth $37.70.

Bone meal contains 3 per cent. N, 18 per cent. P_2O_5; if the organic value for N and the inorganic for P_2O_5 are used it would be worth $70.29 per ton, the selling price is $90 per ton; if the inorganic N value is adopted the value would be $45.30.

The discrepancy between unit values of inorganic and organic manures is striking. Advocates of the latter claim that special benefits follow their application because organic matter is added to the soil and because the nutrients become available only as decomposition proceeds, thus providing the plant with a steady source of food. These claims do not meet with unqualified general acceptance.

Three main considerations govern the choice of a particular manure from those supplying the required nutrient at approximately equal prices. These are—retention by the soil, effect on, and availability in, the soil.

Only water soluble manures are in themselves exposed to the danger of leaching, although insoluble manures might be washed off the surface if broadcast just before a tropical storm. In point of fact nearly all soluble manures are retained by the soil either by absorption or after chemical change, the exceptions being nitrates and possibly urea. Nitrate should not be employed

in quantity on free draining soils where heavy rainfall may be experienced at any time. Insoluble manures may, as a result of change in the soil, give rise to soluble, easily leached products *e.g.* calcium cyanamide gives rise to nitrates. The latter, however, are produced gradually and the opportunity is given for absorption by crops.

Effect on the soil. As indicated in Table A certain manures have definite acid or basic characters and in certain types of soil these should be taken into account if repeated applications are contemplated. Ammonium sulphate, itself a neutral salt, in the process of nitrification (conversion to nitrates) gives rise to nitric and sulphuric acids which normally are neutralised by the bases present. When, however, bases are low (as they notably are in Malayan inland soils) there is danger of depletion by continual application leading eventually to undesirable acidity unless liming is practised.

Sodium nitrate, another neutral salt, may have undesirable effects on heavy clays for opposite reasons; the nitrate radicle is absorbed by the crop, leaving sodium hydrate or carbonate behind which deflocculates the clay, and there is therefore danger of making the land unworkable by repeated applications.

There has been considerable argument over the effect of superphosphate, but the general opinion is that it does not lead to acidification.

Availability. Most manures undergo change in normal soils, nitrogen whether as complex organic compounds in natural manures and organic fertilisers, or as ammonium salts or cyanamide, becomes transformed by bacterial action into nitrates, while soluble phosphates are more or less rapidly converted into insoluble calcium, iron or aluminium phosphates.

Potash salts undergo no chemical change but are 'fixed' as part of the soil complex.

Insoluble phosphates such as basic slag and rock phosphates are normally persistent.

Plants can absorb nutrients only in solution,* hence the practice of estimating in phosphate manures as that portion of the total P_2O_5 the 'available' P_2O_5 which is soluble in water or dilute acid and the assumption that residual P_2O_5 is only available, if at all, after the lapse of considerable periods. This theory undeniably applies to neutral or very faintly acid soils in which reversion is mainly to calcium compounds, but does not necessarily apply to highly acid soils, where the P_2O_5 of basic slag or rock phosphate may possibly be comparatively readily brought into solution, more especially if the manures are in a fine state of division, a state which should be insisted on by the purchaser. Reversion of soluble phosphates such as superphosphate or "ammonium phosphates" in such soils may be expected to be in the direction of iron phosphate which, especially at the pH of such soils, is highly insoluble. Theoretically therefore

* The vexed question of absorption of colloids is omitted from this discussion, it does not affect the argument.

the relations holding in temperate soils may be reversed in acid tropical soils and in view of the relative cheapness of rock phosphate this is clearly a matter of great economic importance and demands thorough investigation.

Unfortunately, although "availability" is a simple concept, no completely satisfactory laboratory method of analysis has yet been devised for measuring the available plant food in the soil either before or after manuring. This is not surprising when it is realised that it depends on chemical composition of the soil, texture, biological action, absorption and chemical change of added manures and the plant itself.

For a similar reason, *viz.* the complexity of the problem, chemical analysis in itself is useless as an accurate guide to manuring, all that can be done is to say that there is a possibility from the analysis that deficiencies exist. (When a mass of local information on the effect of manuring has been accumulated for a particular soil type, then analysis may be useful as means of identifying similar types elsewhere). The only satisfactory means of testing either the manural requirements of particular soils or crops or the action of particular manures is by means of plants and in the last resort, since plants differ widely in their needs, tests must be conducted with every crop. Again only actual long continued application can solve the problem of effect on the soil.

Manurial Experiments.

Most of the work now to be described was carried out in pot culture. This form of experimentation has well known disadvantages — if exposed to weather there is heavy leaching, the soil is perforce disturbed by filling the pots, harvest is necessarily small and the larger annuals such as maize do not as a rule grow well to maturity. On the other hand pots are convenient and once the experiments are recognised as preliminary explorations, can give valuable results which can later be further tested in the field.

Experiment I. The first experiment was carried out with ragi (*Eleusine Coracœra*) and was designed to ascertain the essential elements of manuring in respect of the commonest inland soil types. From the analyses given in Part I, it appears that phosphorus is most and potash least likely to be deficient in our soils. There is definite acidity and the effect of liming requires exploration. Soils of three types were employed, viz. Raub high level* (locally known as laterite), granite and quartzite high level. Pots were triplicated, held 15 kilos of soil and were in the open.

The following applications were given alone or in combination —

Cattle manure at the rate of	10	tons per acre †
Lime	2.5	do.
Green manure (Centrosema)	3	do.

* For a description of these types see Part I of this series.

† Calculated on a basis of a conventional figure of 1000 tons of soil per acre-foot.

Acid sodium phosphate to supply approx.	60 lbs.	P_2O_5 per acre	P
Acid potassium	do.	60 ,, P_2O_5 ,,	PK
		40 ,, K_2O ,,	
Potassium chloride	do.	40 ,, K_2O ,,	K
Urea	do.	20 ,, N ,,	N
Sodium sulphate	do.	35 ,, Sulphur ,,	S
Gypsum	do.	60 ,, Calcium ,,	Ca

Table B.

Result of Pot Culture Experiment with Ragi.

Treatment.	Quartzite hill.		Raur hill.		Granite hill.	
	Average wt. of grain per living plant. Grams.	Average dry wt. of 1 plant. Grams.	Wt. of grain per plant. Grams.	Dry wt. of 1 plant. Grams.	Wt. of grain per plant. Grams.	Dry wt. of 1 plant. Grams.
Control ...	0.17	1.3	0.37	1.8	0.42	2.5
Control Lime ...	0.27	1.3	0.51	1.6	0.35	1.5
Ca. S ...	0.33	1.7	0.25	1.2	0.84	1.2
Lime, S ...	0.24	1.2	0.58	1.2	0.40	1.3
N P K ...	1.24	5.2	2.32	6.8	1.46	3.9
N P K Lime ...	0.69	2.0	0.88	2.1	0.54	1.7
N P K Lime S ...	1.35	4.1	2.00	7.0	0.90	4.3
N P K, Ca, S ...	1.43	5.3	2.35	5.7	1.11	3.82
N P ...	1.47	4.8	2.76	9.5	1.08	3.2
P K ...	0.59	2.6	2.40	5.6	0.66	2.2
N K ...	0.20	1.4	0.89	2.3	0.39	1.9
P ...	1.00	2.9	1.65	5.5	1.0	3.2
N ...	0.69	3.2	0.5	2.1	0.47	1.9
Cow dung ...	1.40	5.5	3.95	10.9	1.82	5.6
Cow dung + Lime	2.18	5.9	6.75	12.3	4.10	9.5
Green Manure ...	0.28	2.7	0.84	2.5	0.41	1.8
Green Manure + Lime	0.46	2.0	1.26	4.4	0.54	1.7
Green Manure + ½ NPK	1.17	4.3	1.87	4.7	2.00	3.8
Green Manure + Lime	1.41	5.5	1.41	4.4	1.42	5.1

Ca = Calcium as sulphate.

S = Sulphur as Sodium sulphate.

Sodium and potassium phosphate were employed to avoid the possible effect of calcium in super or basic slag and urea to avoid sulphur in ammonium sulphate and calcium in cyanamide. Gypsum was employed to test the effect of calcium as a food as distinct from the neutralising action of lime.

Pots were filled and allowed to settle for two months.

Lime was applied 9 weeks, green manure and cow dung 8 weeks, artificials except urea 4 weeks, urea 2 weeks before transplanting of seedlings which had been germinated in garden soil until 3" high. There was considerable mortality and unevenness of growth in the poorer pots. Results (weight of plants and grain) are given in Table B and show clearly the poor yield of the control, the fact that calcium, sulphur and potash appear to be unnecessary, that phosphorus is the key element and that nitrogen is necessary. Lime in the large dressing given reduced the increase due to artifiicials, but increased that due to cattle manure. Green manure alone or with lime gave poor results, but with a small dressing of artificials gave good results.

The discordant results of lime on artificials and on cattle manure may possibly have been due to reduction of solubility of phosphate in the first case and acceleration of decomposition in the second. The acidity of the soils was clearly not injurious to ragi. It was apparent that no real differences of response existed between the three soils employed.

The clear indication from this experiment of the importance of phosphorus led to considerable laboratory work on the subject with the especial object of tracing the fate of phosphatic fertilisers added to the soil. This work was fruitless and it need only be said here that all methods agreed in showing very low concentrations of total and "available" phosphorus in our soils and exceedingly high and rapid fixation of added soluble phosphates.

This high adsorption (or reversion) appeared to strengthen the case for the theoretical possibility put forward above that additions of small quantities of soluble phosphate might not influence plant growth, being entirely adsorbed by the soil, and that the addition of considerable quantities might be necessary for response. Experiment I did not support this view, but the quantity of P_2O_5 applied was not small and it was clearly necessary to test other plants which might possess less efficient means of adsorption.

Experiment II. Another series of pot experiments was started in which gingelly (*Sesamum indicum*) was used, this plant having been found to be highly sensitive to deficiency of P_2O_5. It was decided to limit observation to the first six weeks of growth as the absorption should be high during this period and differences of availability should exercise their maximum effect. Small pots holding 1 kilo of soil were used and quantitative observations on growth were made. Manures were applied approximately 2 to 3 weeks before planting.

Treatments were — cattle manure, superphosphate, basic slag, ferric (iron) phosphate, aluminium phosphate and Sterameal—a proprietary complete organic mixture on the local market — all adjusted to supply P_2O_5 at the rate of 30, 60, 120 and 240 lbs per acre.

Three soils were employed — Raub high level and quartzite high level as in Experiment I and an infertile dark quartzite valley soil from the Government Experimental Plantation, Serdang, and treatments were triplicated. The pots were kept in a plant house and watered daily, leaching being avoided.

The lower applications of cattle manure were at the rate of 2.5 and 5 tons per acre. These quantities are far below normal field applications but were applied to test possible specific effects of this manure apart from the effect of massive applications of N, P and K in the larger dressings. Pots treated with super, basic slag, iron and ammonium phosphates and controls received a dressing of ammonium nitrate supplying N at the rate of 25 lbs. per acre. It was realised that increasing quantities of nitrogen and potash were supplied by cattle manure and Sterameal but this had to be accepted.

Results of the four weeks showed very poor growth of controls and very little benefit from iron or aluminium phosphates on all soils. Cattle manure was little if at all better than equivalent dressings of basic slag on the quartzite and Raub high level but definitely better at all concentrations on the quartzite valley soil. Basic slag was much better than super on the quartzite hill and better at high concentrations on Raub. Sterameal was about equal to basic slag on all soils. After six weeks the results were approximately as shown in Table C.

Table C.

Quartzite Hill.

Manure.	lbs. P_2O_5 per acre.			
	30	60	120	240
Cattle ...	Good	Medium	Good	Medium
Superphosphate ...	Poor	Poor	Poor	Poor
Basic slag ...	Good	Good	Good	Very Good
Aluminium phosphate ...	Very Poor	Very Poor	Very Poor	Very Poor
Ferric phosphate ...	"	"	"	"
Sterameal ...	Poor	Medium	Very Good	Very Good
Control ...	Very Poor			

Quartzite Valley.

Manure.	lbs. P_2O_5 per acre.			
	30	60	120	240
Cattle ...	Good	Very Good	Very Good	Good
Superphosphate ...	Medium	Medium	Medium	„
Basic slag ...	Poor	„	„	Medium
Aluminium phosphate ...	Dead	Dead	Dead	Dead
Ferric phosphate ...	„	„	„	„
Sterameal ...	Medium	Poor	Medium	Poor
Control ...	Dead			

Raub High Level.

Cattle ...	Dead	Poor	Poor	Medium
Superphosphate ...	Poor	Medium	„	Good
Basic slag ...	„	„	Medium	„
Aluminium phosphate ...	Very Poor	Very Poor	Very Poor	Very Poor
Ferric phosphate ...	„	„	„	„
Sterameal ...	Medium	Poor	Good	Very Good
Control ...	Very Poor			

Facts which stand out are the specific effect of cattle manure on the quartzite valley soil, the superiority of basic slag over superphosphate on quartzite hill soil, the large dressings needed on the Raub soil to produce marked effect, the poor effect of cattle manure on the Raub soil, the absence of special advantages from the organic mixture in economic applications, and the uselessness of iron and aluminium phosphates. Superphosphate even in the smallest dressing gave some response on all soils and where small dressings gave poor results large dressings did not improve matters; it does not appear therefore that absorption or fixation entirely removes it from the sphere of even very young plant roots.

The absence of very large differences between the action of superphosphate and basic slag on Raub and quartzite valley soils also casts doubt on the theory that soluble phosphates are fixed beyond the reach of plants, and suggests that some other explanation must be found for differences between the action of the two manures where such exist. The negative results with iron and

aluminium phosphates at first sight appear either to contradict the deduction in the preceding paragraph or the previous suggestion that in our soils fixation occurs by iron, but it must be remembered that, although finely powdered, the phosphates added were in an infinitely coarser state of division that would be iron-fixed phosphate formed in the soil.

During the course of the experiment it became clear that the pots were too small to be entirely satisfactory. There was rapid drying out of the surface owing to the high temperature of the plant house and even with daily watering the plants may have suffered from violent fluctuation of water content of the soil. The next step was therefore to lay out small scale field tests.

Experiment III. Soils used were as in Experiment II, planting was carried out on slightly raised beds, 4′ x 4′, in the field, and nitrogen was studied as well as phosphorus. Beds on the quartzite valley and Raub soils were situated at the Government Experimental Plantation, Serdang,* on the quartzite hill at the Experimental Plantation, Kuala Lumpur. The latter soil was particularly sandy and had been heavily eroded for many years. Crops used were maize, dry padi and sweet potatoes. The second, as usual with small isolated areas of padi, was heavily attacked by borers and the potatoes by pig and insects. Neither came to maturity but as far as could be judged by vegetative growth over a period of 6 — 8 weeks would have given results in general agreement with those for maize detailed below in Table D.

Treatments were in duplicate for each crop and were designed in the case of artificial to supply 35 lbs. N, 50 P_2O_5 50 K_2O and 50 lbs. magnesium oxide per acre, and to test acid against basic manures. Owing to a prolonged dry spell in the second half of the experiment setting of ear was poor and ripening very uneven, in consequence reliance cannot be placed on harvested weights. There was however remarkable agreement between duplicates for vegetative growth, which generally was best on the Raub and worst on the quartzite valley soil.

Dates of treatments were as follows—Lime applied 2nd and 3rd February 1932; green and cattle manure 15th—16th February; super, basic and rock phosphates 1st—2nd March; sulphates of potash, ammonia and magnesium and "ammonium phosphate" 3rd—4th March; all other fertilisers 7th—8th March. Planting 22nd—25th March. The differences detailed in Table D manifested themselves early and continued all through. Reasons for the various mixtures are obvious and need not be detailed.

Observations which confirm those of Experiment I are —

(*a*) The soil quite definitely needs treatment.

(*b*) Phosphorus is the key element, but nitrogen is also necessary.

(*c*) Neither nitrogen alone nor nitrogen and potash mixed without phosphorus are useful.

(*d*) Cattle manure is excellent.

(*e*) Lime is not necessary and does not even improve green matter.

* Plots at the Government Experimental Plantation, Serdang, were in charge of Messrs. T. D. Marsh and J. L. Greig.

Table D.

Appearance of Maize at end of May.

		Quartzite Hill	Quartzite Valley	Raub Hill
1.	Superphosphate ...	Poor	Very poor	Medium
2.	Basic slag ...	Good	Medium	Medium
3.	Rock phosphate ...	Medium	Poor	Very poor) Medium)
4.	Control ...	Poor	Very poor) Poor)	Dead) Poor)
5.	Basic slag and lime (1 ton) ...	Medium	Very good) Good)	Good) Medium)
6.	Basic slag + Pot. sulphate ...	Medium	Very good	Very good
7.	do. do. + cyanamide	*Very good*	*Very good*	*Very good*
8.	do. do. do. + lime	Very good	Very good) Good)	Very good
9.	Basic slag and cyanamide ...	Medium	Very good) Medium)	Very good) Good)
10.	Ammonium phosphate ...	Very poor	Very poor) Dead)	Dead) Medium)
11.	Ammonium sulphate + super ...	Poor	Medium) Very poor)	Medium) Poor)
12.	Basic slag, cyanamide and lime ...	Medium) Poor)	Medium	Good) Very good)
13.	Rock phosphate and cyanamide ...	Poor	Medium) Poor)	Poor) Very good)
14.	Basic slag and castor cake ...	Good) Poor)	Very good) Good)	Good) Very good)
15.	Control ...	Poor	Very poor	Dead) Very poor)
16.	Cyanamide and Pot. sulphate ...	Poor	Medium) Good)	Poor
17.	Cyanamide ...	Poor	Very poor) Medium)	Poor) Very poor)
18.	Amm. sulphate ...	Dead) Poor)	Dead	Poor) Dead)
19.	Castor cake ...	Poor) Medium)	Poor) Very poor)	Medium
20.	Cattle manure (2½ tons) and basic slag ...	Very good) Good)	Very good	Very good) Good)
21.	Cattle manure (10 tons) ...	*Very good*	*Very good*	*Very good*
22.	Cattle manure and lime ...	*Very good*	*Very good*	*Very good*
23.	Steramcal 500 lbs. ...	Good	Very good	Very good
24.	Steramcal 240 lbs. ...	Poor) Medium)	Very poor) Medium)	Medium
25.	Green manure 3 tons ...	Poor	Very poor	Medium) Poor)
26.	Green manure and basic slag ...	Poor) Medium)	Medium	Good
27.	Green manure and lime ...	Poor	Medium	Medium) Poor)
28.	Control ...	Very poor) Poor)	Dead	Medium) Dead)
29.	Basic slag, cyanamide, Magnesium sulphate ...	Very good	Good	Very good) Medium)
30.	Lime ...	Poor	Medium	Medium) Poor)

Where only one description is given, duplicates agreed perfectly.
Italics indicate outstanding merit.

Observations which go further are —

(*a*) Of P alone, on both quartzites, superphosphate alone is poor, basic slag best and rock phosphate intermediate; on Raub basic slag and super are equal.

(*b*) Of N alone, ammonium sulphate appears to be injurious.

(*c*) Of NP mixtures, "basic" cyanamide-basic slag is definitely superior to "acid" ammonium sulphate-super on all soils, while most unexpectedly "ammonium phosphate" is toxic.

(*d*) Potash is necessary for best growth and even without nitrogen enhances the effect of phosphorus.

(*e*) Green matter appears to be useless.

(*f*) The complete organic manure in normal application was not effective.

(*g*) Castor cake mixed with basic slag gave good but not excellent growth and in this case excess expenditure for N in organic form would not have been recovered. It is of course legitimate for the advocates of organic fertilisers to argue that the experimental period was too short to permit thorough decomposition of either Sterameal or castor cake.

(*h*) Magnesium is not essential.

The excellent effect of cattle manure on all soils in this experiment is in opposition to the results in Experiment II; as stated above the latter experiment cannot be considered to be satisfactory. The superiority of basic slag over superphosphate on quartzite hill may be taken as proved and the very marked superiority of the basic NP mixture suggests that the explanation may be found in the difference of reaction between the two fertilisers rather than reversion to unavailable iron phosphate.

Both for cyanamide and basic slag there is also the possibility that the application of a relatively small quantity exactly where it is wanted,* *viz.* in intimate contact with the manure particles, may do good even though mass applications of large quantities do not improve the effect of acid manures. The lime in the latter case cannot be mixed with the manure (or loss of ammonia as gas and reversion of phosphate would occur) and in a limited period there is no guarantee that a majority of manure particles or of soil particles which have adsorbed manure ever encounter particles of lime. Previous experiments† had shown that nitrification of both ammonium sulphate and cyanamide proceeded normally.

It was decided to carry out further investigations on combinations of NP manures.

Experiment IV. The large pots of Experiment I and quartzite hill soil were employed. Pots were in the open and were replicated. Applications were made as follows — lime three weeks, basic slag, super phosphate and rock

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* c.f. the views of Crowther. J. Ag. Sc. 22, p. 329, '32.

† Belgrave, W. N. C.; this Journal 17, p. 192, '29.

phosphate two weeks, ammonium sulphate, cyanamide, urea and "ammonium phosphate" one week before sowing of gingelly. Quantities used supplied P_2O_5 at the rate of 50 lbs. and N 35 lbs. per acre, lime was applied at the rate of 2 cwts. per acre, sufficient to neutralise acidity from nitrification of ammonium sulphate (if contact was effected.)

Germination was excellent except on "ammonium phosphate" and the plants were thinned out to 3 per pot after a week.

Table E describes the plants after 17 days and after 2 months' growth.

Agreement between replicates was very good. After this period, when the better plants were in flower all plants lost ground and exhibited signs of ill-health. This point will be discussed later.

Table E.

Growth of Gingelly.

Treatment	After 17 days	After 2 months
Lime and am. sulph. and super ...	Fair	Fair
Am. sulph. and super ...	Poor	Dead
Am. sulph. and basic slag ...	Poor	Dying
Cyanamide and super ...	Good	Good
Cyanamide and basic slag ...	Very good	Very good
Am. phosphate ...	Very poor. dying	Dead
Am. phosphate and lime ...	Fair	Poor
Urea and super ...	Fair	Dying
Urea and basic slag ...	Very good	Very good
Cyanamide and rock phosphate ...	Very good	Very good
Am. sulph. and rock phosphate ...	Poor	Dead
Control ...	Very poor	Dead

It is obvious that the preponderant influence of 'acid' and 'basic' is exercised by the nitrogenous manures and that cyanamide is definitely valuable. Rock phosphate is here valuable and has been found to be so in a number of subsequent experiments, poor results given by it in Experiment III await explanation.

The toxic influence of "ammonium phosphate" is definite and is not eliminated by lime. In order to test residual effect of all manures and particularly possible residual toxic effect of ammonium phosphate, after removal of gingelly, maize was sown without further treatment. Growth at the end of 1 month was as in Table F.

Table F.

Growth of Maize.

Previous Treatment	Result
Lime and am. sulph. and super	Very good
Am. sulph. and super	Poor
Am. sulph. and basic slag	Good
Cyanamide and super	Fair
Cyanamide and basic slag	Very good
Am. phosphate	Very poor
Am. phosphate and lime	Medium
Urea and super	Medium
Urea and basic slag	Medium
Cyanamide and rock phosphate	Very good
Am. sulph. and rock phosphate	Medium
Control	Medium

After this period all plants rapidly went off.

Clearly cyanamide is still exerting its good influence, added lime appears now to have overcome the bad effect of the acid am : sulph : super mixture and the bad effect of ammonium phosphate persists thus answering a possible criticism that it had previously been applied too soon before sowing.

The ammonium phosphate used in Experiments III and IV was a mixture of two grades of German origin and there seemed a remote possibility that material made by other manufacturers might behave differently.

Experiment V. Large pots with quartzite soil were treated with (*a*) British, (*b*) German ammonium phosphate mixtures, (*c*) cyanamide and basic slag all to supply quantities of N and P_2O_5 as in Experiment IV, and (*d*) control. Each treatment was replicated six times, three pots being sown with

gingelly and three with maize. Results exactly confirmed those of previous experiments; there was no difference between the results from German and British material and both were definitely toxic.

Experiments IV and V were NP mixtures, but Experiment III had indicated potash as desirable for best growth, at any rate when a basic mixture was employed. It was now necessary to test the effect of potash in acid mixture and in ammonium phosphates.

Experiment VI. Large pots, maize and gingelly were used. Applications of "acid" (am. sulph. super) "basic" (cyanamide and basic slag) and ammonium phosphates were made as in Experiments IV and V to half the pots, sulphate of potash to supply K_2O at the rate of 35 lbs. per acre was added. There were 4 replicates of each treatment which showed good agreement. Unfortunately very heavy rains were experienced about 3 weeks after sowing which caused falling off of growth earlier than usual.

Results were—potash reduced the extreme toxicity of ammonium phosphate and improved all mixtures but did not alter their order of merit.

Two pots each of maize and gingelly were tested with ammonium phosphate to which calcium sulphate had been added, growth was very bad and worse than those to which potash had been added.

*Experiment VII**. About this time experiments to be described in Part III of the series indicated that the poor results from green manure in Experiments I and III might have been due to the fact that it was turned in too long before planting of seed and that further exploration was desirable. Accordingly large pots were filled with quartzite hill soil, acid and ammonium phosphate mixtures of the previous experiments (without potash) and cyanamide and rock phosphate were applied one week before planting and cuttings of carpet grass (*Axonopus compressus*) turned in at the rate of 20 tons per acre on the day of sowing maize and gingelly. There were three replications of each treatment.

The pots without grass gave the usual results *i.e.* ammonium phosphate killed gingelly early and seriously damaged maize, the acid mixture gave poor medium growth and the cyanamide rock phosphate mixture excellent growth for about two months with both maize and gingelly.

The grassed pots showed marked differences, gingelly was completely killed as usual by ammonium phosphate and received a severe check from grassing on the other two mixtures lasting 4—5 weeks. Maize benefited from grassing in all cases from the start.

Gingelly in the acid and basic pots threw off the check and rapidly overhauled the ungrassed pots and with maize made excellent growth up to the time of fruiting. Seed was set well from gingelly but the maize cobs did not fill. There were still slight differences in favour of cyanamide and rock phosphate and ammonium phosphate was definitely poorest with maize.

* This experiment was performed by Mr. R. G. H. Wilshaw.

Summary of results and conclusion from Experiments I - VII.

The experiments have proved that phosphorus and nitrogen are essential for good growth of all annuals tried. Potash was not essential for ragi but definitely improves maize and gingelly when added to NP mixtures in the absence of green matter. Basic slag is better than superphosphate on quartzite soil but it cannot be proved that this is due to reversion of the latter to an unavailable form.

Cyanamide is definitely better than ammonium sulphate in NP mixtures especially in the absence of fresh green matter.

Heavy liming is unnecessary and may with artificials do harm, but a small quantity of lime, if contact could be effected, would probably improve ammonium sulphate. The excellent effect of cyanamide and basic slag may well be due to intimately mixed lime or lime producing materials.

There appears to be no shortage of calcium (as a nutrient), magnesium or sulphur.

Continued growth of maize and gingelly was impossible in pots without the incorporation, immediately before planting, of green matter.

Green matter turned in six weeks before planting had little effect even if mixed with phosphate and will be shown in Part III to have a transient effect if turned in alone early.

Rock phosphate gave excellent effect in pots but surprisingly failed in small scale experiments in the field.

Ammonium phosphate with or without green matter, lime or potash appeared to be detrimental to annuals on the soils explored. Cause of injury is very obscure but does not appear to be related to calcium starvation since addition of calcium sulphate did not help.

Little or no change of acidity has been found in any of these experiments and the reactions which undoubtedly take place must be limited to the immediate neighbourhood of added fertilisers.

Cattle manure gave excellent results except in Experiment II.

A series of exploratory experiments has been conducted recently by Field Officers with maize on duplicated beds 6′ x 6′ using complete (NPK) acid basic and ammonium phosphate mixtures, cattle and green manure (without artificials).

Results from green matter were uniformly poor, confirming observations described above. Only in two cases did the basic mixture show superiority and only in one case was ammonium phosphate lethal. Addition of potash may have helped to level up the mixtures. Cattle manure was nowhere outstanding and nowhere was growth really satisfactory.

Striking confirmation of the superiority of basic over acid mixtures has been obtained in a replicated manurial experiment on guinea grass conducted at the Government Experimental Plantation, Serdang, in connection with fodder investigations. Results will be published later by Mr. V. R. Greenstreet.

On the practical side a replicated experiment with plots of 1/40 acre is being laid out at the Government Experimental Plantation, Serdang, to test growth of various annuals with turning in of green matter, leguminous and non-leguminous, in conjunction with various manures. A smaller version of this experiment is also to be laid down on several Agricultural Stations scattered about the country. Once the best treatment for green manure and the minimum requirement for nutrients have been determined on a field scale it should be comparatively simple although time-consuming to determine the correct kind of manure to supply that nutrient.

Until this work is completed it would appear safer to rely for the present on basic NP mixtures together with green matter turned in early for the growth of annuals on previously cultivated soils.

Calcium cyanamide has fallen into disfavour in the United Kingdom, three charges being made against it, (*a*) formation of a toxic compound in soils, (*b*) deterioration in opened packages and (*c*) injury to the skin of labourers; it is also slightly more expensive than ammonium sulphate. Modern preparations should not exhibit toxicity and no trace of it has yet been encountered in these and other local experiments, even where it was applied as a part of a mixture as top-dressing to backward maize; all the cyanamide used in these experiments has been kept in paper lined gunny bags without any more serious consequences than the formation of a thin crust on the exterior; skin injury can be avoided by a preliminary coating of vaseline on hands and arms. This manure is not manufactured in the British Empire.

Experiments are being laid down to test the possibility of enhancing the effect of ammonium sulphate by preliminary mixing with chalk or very finely powdered limestone (lime cannot be used) but until these results are known it would appear desirable to rely on cyanamide as source of nitrogen.

In view of the comparative failure of rock phosphate in Experiment 111 it would appear better for the present to rely on basic slag; further experiments are necessary before it can be said with certainty that this manure can be effectively replaced for this class of cultivation by the cheaper rock phosphate.

Local supplies of phosphates occur in Perak, Kedah, Perlis and Kelantan with in general P_2O_5 content ranging from 20—25 per cent. and in some case a satisfactory standard of solubility in dilute acids. Export to other States is however restricted and methods of exploitation somewhat haphazard. Cases have occurred of samples with a P_2O_5 content as low as 6 per cent. finding their way to the market and although good samples should be as efficient as imported rock phosphate care should be taken to purchase only material of guaranteed composition and fineness of division.

Ammonium phosphates should clearly be avoided. From Experiment VII potash would not appear to be necessary provided the essential addition of green matter is carried out.

It is clear that this discussion has left many points of the highest interest in the behaviour of our soils unsolved. The most interesting is the behaviour of green matter—why must it be turned in late? Is the formation of "humus" in our soils, a myth and does benefit accrue only when the first vigorous decomposition of sugars and proteins is in progress. If so, why should the benefit conferred outlast this period of rapid decomposition? Does decomposition in the soil give rise to iron humate without which iron may be unavailable? Or does it result in increase of available nutrients by accelerating mineral breakdown? A further discussion of some of these possibilities will be found in Part III of this series.

In any case it appears that green manure may obviate the use of potassic manures for certain crops and it is hoped that it may be found that nitrogen also is capable of reduction or elimination. Cheapness is essential for economic employment of manures on low-value tropical food crops. If cheap manures prove to be ineffective large scale cultivation of annual crops other than wet padi may have to be ruled out from the programme of general agricultural development on the greater part of the very old, heavily leached inland soils of Malaya.

Other Crops and Soils.

It is to be clearly understood that both observations and recommendations above refer to annual crops on the general run of inland soils, conditions may be and undoubtedly are totally different for larger and more permanent forms of cultivation, and possibly for annual crops on alluvial coastal soils, on pockets of rich river alluvium in inland districts and on the volcanic soils of Pahang. Manuring on the less impoverished and frequently very heavy coastal clays and on peaty and organic soils presents special problems and demands special study. In the Departmental manurial experiments on Oil Palm phosphorus alone appears to be necessary for enhanced crop production where unmanured yields are low, but ammonium sulphate in an acid NP mixture has not reduced yield on quartzite hill soils; this is not surprising as the root system may be stronger than that of an annual and, as explained in the introduction, absorption is probably slower thus giving more time for adjustment of internal equilibrium to the plant. It is understood that ammonium phosphate has given good results in estate manuring of oil palms.

In view, however, of the weak buffering (*vide* Part I) of our inland soils it would appear inadvisable to risk souring or undue extraction of bases by long continued application of acid manures or mixtures. Alternation of acid and basic or two applications of acid to one of basic would probably maintain a balance.

Coconuts growing on heavy soils have not so far shown response to manuring.

In addition to experiments on coconuts and oil palms* experiments are in progress at one or other of the Departmental Stations on manuring of tea, coffee, pineapple, arecanuts, pepper and tapioca. In most of these, acid and basic mixtures are undergoing comparison so that in a comparatively short time, measured in years, there should be that body of information on manuring in Malaya which has long existed in those countries which have in the past relied on agricultural rather than forest products.

Summary.

General considerations on manures and manuring are discussed.

An account is given of experiments on small scale manuring of annual crops on inland soils from which phosphorus and nitrogen are seen to be necessary and best applied in basic form.

Future work is outlined and recommendations made for immediate use.

All pot experiments were carried out by Haji Abdul Wahid bin Haji Jaffar, Acting Malay Research Officer. The writer desires to acknowledge his care and accuracy of observation.

*Described in this Journal Vol. XX, p. 105, 304; 1932.

EXPERIMENTAL WORK IN RELATION TO PINEAPPLES.

BY

G. D. P. Olds,

Agricultural Field Officer, Singapore.

With an Appendix,

BY

J. H. Dennett,

Acting Plant Physiologist.

Introductory.

An Experiment Station, which is under the charge of the Agricultural Field Officer, Singapore, and is situated at Lim Chu Kang some seventeen miles from Singapore town, was opened up in the year 1930 primarily to provide facilities for conducting field experiments with pineapples. At the same time it was recognised that such a Station should also provide facilities for small scale experiments with certain other crops and for the distribution of planting material of fruit trees. Owing, further, to the necessity for investigating crops which could be grown in rotation with pineapples, experiments on other crops notably tobacco have also been included in the programme of work.

Visitors to the Station have been numerous for some time and the work has aroused considerable interest in many sections of both planting and business communities.

The following report on the experiments conducted with pineapples gives an outline of the progress made from June 1932 to the end of the first crop of pineapples, the approximate date for which was March 1933.

Experiments.

In June 1932, the position with regard to pineapple experiments was as follows :—

Three main experiments had been laid down as follows :—

(i) A randomised block manurial experiment, containing seventy-two one-twentieth acre plots, there being 12 treatments each repeated six times.

(ii) A cultural treatment experiment, containing 10 plots of 1 sq. chain each, 5 different cultural treatments being represented in the experiment.

(iii) A combined planting distance and manurial experiment, consisting of 24 plots of 1 sq. chain each, with 4 different planting distances.

Since the primary objects of the experiments are to discover the most suitable dressing of manures, the most suitable planting distance and the best cultural methods, on land which had previously been occupied by pineapples, and which is typical of considerable areas of Singapore and Johore land, the results of the above experiments, taken to the end of the first crop, are of considerable interest.

Manurial Experiment.

The 12 manurial dressings applied were as follows :—

(1)	Lime only	—	½ ton per acre.
(2)	Lime	—	½ ton per acre.
	Sulphate of Ammonia	—	100 lbs. per acre.
	Superphosphate	—	300 lbs. per acre.
	Sulphate of Potash	—	100 lbs. per acre.
(3)	Lime	—	½ ton per acre.
	Sulphate of Ammonia	—	100 lbs. per acre.
	Superphosphate	—	300 lbs. per acre.
	Sulphate of Potash	—	100 lbs. per acre.
	Magnesium Sulphate	—	240 lbs. per acre.
(4)	Control	—	no manure.
(5)	Sulphate of Ammonia	—	100 lbs. per acre.
	Superphosphate	—	300 lbs. per acre.
	Sulphate of Potash	—	100 lbs. per acre.
(6)	Sulphate of Ammonia	—	100 lbs. per acre.
	Superphosphate	—	300 lbs. per acre.
	Sulphate of Potash	—	200 lbs. per acre.
(7)	Sulphate of Ammonia	—	100 lbs. per acre.
	Superphosphate	—	300 lbs. per acre.
	Sulphate of Potash	—	100 lbs. per acre.
	Magnesium Sulphate	—	240 lbs. per acre.
(8)	Superphosphate	—	300 lbs. per acre.
	Sulphate of Potash	—	100 lbs. per acre.
(9)	Sulphate of Ammonia	—	100 lbs. per acre.
	Superphosphate	—	300 lbs. per acre.
(10)	Sulphate of Ammonia	—	100 lbs. per acre.
	Sulphate of Potash	—	100 lbs. per acre.
(11)	Rotted Pineapple Refuse	—	10 tons. per acre.
(12)	Cattle Manure	—	10 tons per acre.

From June 1932, the best growth was exhibited by all plots which were treated with a complete dressing of artificials as in treatments (2), (3), (5), (6) and (7), although a definite response to phosphates was also apparent. The "lime only" plots, and control plots were much less vigorous than the plots

dressed with fertilisers, the difference being particularly marked during spells of dry weather. The appearance of all plots varied with the amount of rainfall and the general impression that the experiments gave was that the unmanured plots were suffering from a definite lack of plant food, whereas the fertilised plots were able to withstand longer periods of drought with less signs of starvation.

Fruiting commenced on a few plots in August 1932, the first plots to produce fruit being those which had been treated with phosphates; at this time also the differences between treatments became more marked.

For the first month, after fruiting commenced, records of the number of fruits per plot only were kept, but subsequently the weights of the fruit per plot were recorded.

The figures given below form a summary of the yields in numbers of fruit per acre and mean weight of one fruit in each plot, taken as an average of six plots, and for the first crop only.

Yields from Manurial Experiment.

Treatment No.	Number of fruits per acre.	Mean weight of one fruit in lbs.
1	153.2	4.08
2	766.0	3.84
3	723.2	4.13
4 (control)	156.0	3.66
5	910.0	3.81
6	1466.6	3.86
7	1063.2	3.61
8	566.6	3.84
9	733.2	3.70
10	270.0	3.60
11	263.2	3.84
12	700.0	3.69

The response to manuring on the first crop has been remarkable. The control plots yielded an average of 156 fruits per acre only as compared with the average of 1466.6 fruits per acre given by the six plots of treatment No. (6) (Sulphate of Ammonia, 100 lbs., Superphosphate 300 lbs., and Sulphate of Potash 200 lbs.) It should be noted also that there is a decided response to the *double* dressing of Potash, since treatment (5) is the same treatment as treatment (6) with the exception that it includes half the amount of Potash, and the figures show a difference of 556 fruits per acre between the two results.

Treatment No. (7) actually gives the next highest yield to treatment No. (6) and this again contains a complete dressing of Nitrogen, Phosphate and Potash (100 lbs.) with the addition of Magnesium Sulphate, but the increase over treatment (5) is relatively small. Since comparison of two other treatments, viz. (2) and (3) also gives the effect of the addition of Magnesium Sulphate and since that ingredient has shown no increase in this instance (there is in fact a decrease), it seems probable that the addition of Magnesium Sulphate to the complete dressing produces no marked increase in yield and is therefore unnecessary.

The remaining treatments call for no special comment, except to indicate the necessity of including Nitrogen, Phosphate and Potash in any mixture of artificial fertilisers. The cattle manure and pineapple refuse treatments both show an increase over the control but the increase is comparatively small.

Since the results of the first crop only are so far available, and prices for pineapples have suffered from continual fluctuation for several months past, it would be unwise at this stage to attempt costings. The experiments have not yet proceeded far enough to indicate the residual value of the fertilisers and for that reason any estimate of cost at this stage would probably be inaccurate.

The conclusions that may be drawn from the manurial experiment to-date may be summarised as follows :—

(i) On old pineapple land of a sandy quartzite nature, some form of reconditioning of the soil is essential if pineapples are to be grown successfully.

(ii) The dressing which has given the highest increase in yield to-date is treatment No. 6 which consists of 100 lbs. of Sulphate of Ammonia, 300 lbs. of Superphosphate and 200 lbs. of Sulphate of Potash. Significantly beneficial results have also been derived from treatments Nos. 2, 3, 5, 7, 9 and 12.

(iii) There is a definite response to Phosphates; the position with regard to Potash is on results so far obtained somewhat contradictory.

(iv) Liming alone, produces no beneficial effect on the number of fruits yielded, although it may increase the weight of each fruit. Liming in combination with other manures appears to have a depressing effect.

(v) Cattle manure at the rate of 10 tons per acre produced a definite increase in yield but the increase does not justify the cost of this fertiliser except where easily and cheaply obtained.

(vi) Fertilisers containing Phosphates give early maturity.

(vii) The following manures failed to benefit the crop significantly :—

(*a*) Lime,

(*b*) Sulphate of Ammonia and Potash,

(*c*) Pineapple refuse.

Green Manurial Experiment.

In addition to the main manurial experiment outlined above a green manurial experiment was laid down in the season 1932—1933.

This is an experiment designed to indicate the respective effect on the growth and yield of pineapples of the following green manures which were changkolled in prior to planting with pineapples.

(i) *Crotalaria anagyroides,*
(ii) *Tephrosia candida,*
(iii) *Mimosa invisa,*
(iv) Ground nuts,
(v) Natural grass, free from "lallang".
(vi) Natural grass, lallang, and weeds.

The above green manures had all been established by June 1932, but no pineapples had been planted. This experiment has since that time been divided into two blocks on one of which pineapples have been planted after one crop of green manure, and on the other after two crops of green manure. The whole of this experiment is now under pineapples and excellent growth has been made to date. Little difference between treatments is discernible as yet but there are signs that the greatest effect is taking place in the "natural grass" and "Mimosa" plots. Each treatment is repeated twice in each block.

All plots in this experiment have so far been unmanured, except for the fertilisers previously applied to the green manure crops. These consisted of Sulphate of Ammonia ½ cwt., Basic Slag 3 cwt. and Sulphate of Potash ½ cwt. per acre.

The planting distance adopted for this experiment is 5′ x 2′ x 2′ double row planting.

Cultural Treatment Experiment.

The cultural treatment experiment laid down consists of 5 treatments each repeated twice, on plots of 1 sq. chain planted with pineapples at 5 ft. x 2½ ft.

The treatments were :—

(1) Mulched with PABCO Thermogen paper.
(2) Forked once annually.
(3) Clean weeded.
(4) Mulched with pineapple refuse.
(5) Unweeded.

All plots in this experiment, owing to their backward growth were fertilised in their early stages with a complete dressing of artificials at the rate of 250 lbs. per acre as follows :—

Sulphate of Ammonia	...	100 lbs.
Basic Slag	...	300 ,,
Sulphate of Potash	...	100 ,,

The results obtained for the first crop from this experiment show very marked differences between treatments, the most outstanding result being that yielded by the PABCO paper mulch plots. Here a very considerable increase both in number and weight of fruit is shown. Significant increases are also given by treatments 3 and 4 while no material benefit appears to be derived from forking.

The figures for the first crop are as follows (taken as an average of 2 plots).

Yield from Cultural Treatment Experiment.

Treatment.	No. of fruits per acre (mean of two plots)	Average weight of fruit in lbs.
(1) PABCO ...	955.00	3.91
(2) Forked once annually ...	121.6	2.38
(3) Clean weeded ...	238.3	3.58
(4) Pineapple refuse ...	426.6	3.64
(5) Unweeded ...	50	2.57

From the above figures it will be seen that the highest yield, as well as the highest average weight of fruit, is given by the PABCO mulch, the next highest is the pineapple refuse mulch, while the effects of the other treatments are well below each of these.

The effects of mulching are clearly demonstrated by these results, since the control plot has an extremely low yield of 50 fruits per acre only.

It is unfortunate that the cost of PABCO paper is prohibitive, since its use is obviously beneficial. It is however, quite out of the question as a practical means of increasing fertility in Malaya, its cost being in the region of $250.00 per acre.

In Hawaii, where labour costs are high and weeding therefore expensive and also where PABCO is comparatively cheap, this form of mulch is very successful. The increase in yield over the control obtained from mulches in this experiment, however, inevitably points to the need for some form of cheap mulch, which could be obtained locally, and this matter is under consideration.

The results from this experiment may be compared with those from the manurial experiment. Taking the two highest yields in each case we have :—

Cultural Treatment	*Manurial Treatment*
PABCO — number of fruits per acre = 995.0	Treatment No. 6 — number of fruits per acre = 1466.6
Pineapple refuse — number of fruits per acre = 426.6	Treatment No. 7 — number of fruits per acre = 1063.2

These results indicate that a greater effect is given by manuring than by mulching—particularly as the cultural plots were manured with 250 lbs. per acre of a complete mixture of artificials. On the basis of these figures, one would recommend manuring rather than mulching, in order to increase yield, but it would probably be highly efficacious to combine the two. The mulching treatment increases the average size of the fruit while manuring increases the number of fruit as well as the size, so that a combination of both treatments is likely to give the best results.

Attention should again be drawn to the fact that the above figures refer to the first crop only and it is therefore unwise to deduce too much from them at this stage. As a broad indication of the success of the various methods of improving fertility however, they may be regarded as extremely useful, especially as they point the way to the lines along which future experimental work needs to be guided.

Planting Distance Experiments.

There are two experiments devoted to investigations of suitable planting distances for pineapples.

The first of these consists of 24 one square-chain plots. Four different planting distances are adopted, and there are six plots of each of these types.

The four planting distances are :—

1. Double row 2′ x 2′ x 5′ giving 6222 plants per acre.
2. Double row 2½′ x 2½′ x 5′ giving 4620 plants per acre.
3. Double row 3′ x 3′ x 5′ giving 3630 plants per acre.
4. Single row 2½′ x 5′ giving 3484 plants per acre.

There are two main blocks, each containing 12 plots; these blocks were fertilised with a complete dressing of artificials at 500 lbs. per acre, and 1000 lbs. per acre respectively, applied in two dressings, with a six months' interval.

For purposes of comparison, therefore, we have :—

Four types of planting distance, each repeated 3 times, and each fertilised at the rate of 500 lbs. per acre of a complete mixture.

The same 4 types of planting distance, each again repeated 3 times but each fertilised at the rate of 1000 lbs. per acre of the same mixture of fertilisers.

The complete mixture used is that known as mixture "A" consisting of :—

Sulphate of Ammonia 100 lbs; Basic Slag 300 lbs; Sulphate of Potash 100 lbs. per acre.

Growth throughout the whole experiment has been good, the plots which received the heavier dressing, however, showing the greatest vigour. Also, growth on the more closely planted plots has, throughout the season, been in

advance of the wider spaced planting. The vegetative growth exhibited by the plots planted with pines at 5′ x 2′ x 2′ double row planting and fertilised at 1000 lbs. per acre approximates very closely to that which one might expect on a good loamy soil.

One disadvantage in the close planting, however, should be noted. It is that on light soils of the nature of the plots under experiment, after the plants have attained full height, difficulty is experienced in cultivating between the two close-planted rows. The tendency is for the soil, when being hoed or weeded, to be earthed up on the outside of these two rows only, so that the plants when bearing fruit, become top-heavy and fall inwards. Since this fact has been realised particular care has been taken to see that all cultivation in the early stages is done with the idea of earthing up from the inside of the two rows, so that later, when this becomes difficult, earthing up on the outside only tends to support the plants. Apart from this cultivation difficulty, which is not a serious one, the close planting and harvesting is quite as easy as with the single row method and, if the yield figures support the method, there is no apparent objection to closer planting.

A summary of the first crop yields is given below :—

Yield from Planting Distance Experiments.

Planting Distance.	Number of fruits per acre.	
	Fertilised 500 lbs.	Fertilised 1000 lbs.
Double row 1. 5′ x 2′ x 2′	540.0	960.0
Double row 2. 5′ x 2½′ x 2½′	793.0	990.0
Double row 3. 5′ x 3′ x 3′	686.0	800.0
Single row 4. 5′ x 2½′	810.0	650.0

A study of these figures indicates that no definite conclusions can yet be drawn. This is further borne out by consideration of the actual figures of yield for each plot, since there is a wider variation between plots than there is between treatments. The figures for each plot are given below to illustrate this point, and the only conclusion that can be made is that an insufficient number of replicates of each treatment is included in the experiment. The actual soil on which these plots were laid out is of a very variable nature, and also contains certain areas where the original jungle growth was burnt in heaps after clearing. These areas are obvious to the eye and will naturally tend to reduce the accuracy of the results. The actual figures per plot in numbers of fruits are :—

Yields per Plot.

Fertilised at 500 lbs. per acre.			
Planting Distance.	Plot No.	No. of fruits per plot.	Mean per plot.
1. 5′ x 2′ x 2′	74	62	
	80	50	54
	95	50	
2. 5′ x 2½′ x 2½′	75	81	
	81	87	79.3
	89	70	
3. 5′ x 3′ x 3′	84	58	
	85	61	68.6
	92	87	
4. 5′ x 2½′	77	67	
	88	144	81
	94	32	

Fertilised at 1000 lbs. per acre.			
Planting Distance.	Plot No.	No. of fruits per plot.	Mean per plot.
1. 5′ x 2′ x 2′	76	111	
	78	117	96.0
	93	60	
2. 5′ x 2½′ x 2½′	73	59	
	83	120	99.0
	91	118	
3. 5′ x 3′ x 3′	82	75	
	87	112	80.0
	90	53	
4. 5′ x 2½′	79	49	
	86	96	65.0
	96	50	

A brief inspection of the above figures will show that the deviation from the mean for one treatment in many cases is greater than the deviation between the mean of one treatment and the mean of another.

It is possible that, with a larger number of fruits, recorded over a considerably longer period, these differences will be reduced to a figure capable of giving a more dependable result, and therefore it will be as well to continue the experiment for some time in order to ascertain if this is the case.

If, after say four crops, the same large discrepancies are shown, the experiment will probably need to be redesigned in order to include a large number of replicates of each treatment.

If the manurial treatment had not been superimposed on top of the planting distance, and all plots had been fertilised alike, there would have been 6 replicates of each treatment instead of 3, with a probable increase in the degree of accuracy.

The second planting distance experiment, is designed to give comparative results between two blocks of pineapples planted very closely, one being fertilised with a complete dressing of artificials at 500 lbs. per acre and the other unfertilised, but both blocks having previously been under green manures. The planting distance adopted is that adopted in some parts of Hawaii *viz.* four rows planted at two feet apart with two feet between plants (diagonal planting) and then a wide row 5 feet away. The rows appear thus when planted :

	5′	2′	2′	2′	5′	2′	2′	2′	

There are ten one sq. chain plots in each block and all the area was planted as above in November 1932. The fertiliser mixture applied was the standard complete mixture "A" consisting of Sulphate of Ammonia 100 lbs.; Basic Slag 300 lbs.; and Sulphate of Potash 100 lbs. per acre.

Growth on all plots in this area since planting has been good, the fertilised half being better than the unfertilised half, and this experiment should yield useful data on the subject of close planting in due course.

Variety Trials.

(*a*) The variety trials consist of one small area under Mauritius pines and one similar area under Sarawak pines, in addition to 100 plants of each of the following varieties :—

(1) Kew,
(2) Bogor,
(3) Conte de Paris,
(4) Ruby,
(5) Montserrat,
(6) Hitam or Merah.

Of the above the following have so far produced fruit : Sarawak, Mauritius, Bogor, Ruby and "Hitam" or "Merah".

Study of the plants during the growing period and in fruit has led to the following conclusions :—

(1) The Kew pine is the same as the Sarawak pine.
(2) The "Bogor" pine is the same as the Mauritius pine, ("Bogor" is the Javanese name for this variety).
(3) "Ruby" is probably another name for the Singapore Queen pine. No important differences between the two varieties have been noted.
(4) Of the varieties planted the only one likely to be of commercial importance in Malaya for canning, is the "Ruby" variety.

All other varieties have spiny leaves which make cultural and harvesting operations so difficult that they are not likely to be adopted for field planting on a large scale.

(*b*) In addition to the above varieties, one hundred plants of the Smooth Cayenne variety obtained from the Department of Agriculture, Java, have been planted out for observation. It is believed that the Smooth Cayenne is either the same as the Sarawak, or a closely allied form.

Recently also it was learnt that two types of Sarawak, one large and one small, are known in Singapore. One hundred suckers of the small variety have been planted out alongside the Smooth Cayenne for comparison purposes.

(*c*) An attempt at crossing the female Sarawak with the male "Queen" pine resulted in a number of seeds being produced in the ripe fruit. Of these seeds four have since germinated and are being kept under observation in pots.

(*d*) Selection of the best plants for propagation, with a view to improvement of general quality, yield etc., has recently been started.

Disease Experiments.

A small scale experiment to determine whether the apparent "wilt" noticed on certain pineapple plants was due to soil poverty or to actual attack by specific disease was conducted during the season. The results of this experiment indicated that it is probable that the so-called "wilt" is caused by lack of sufficient plant nutrients. The experiment is to be repeated.

Periodic examinations of "wilted" plants in the Research Laboratories of the Department have been carried out and in no case was a specific disease due to a micro-organism identified.

APPENDIX.

The results obtained in the foregoing article were submitted to statistical analysis to ascertain whether the various increases obtained with different comparable treatments were of significance or whether they were due to chance.

The three experiments examined were (i) Manurial, (ii) Cultural, (iii) Planting Distances.

The application of the "*z*" test* shewed that only the first two of these experiments were significant. In the planting distance experiment the random variance was three times greater than the treatment variance and therefore the experiment was without significance.

Subsequent application of "*t*" test† to the manurial experiments gave the following figures for the usual standard of significance P = .05 (only a five per cent. likelihood of such results occurring by chance).

Significant difference between any treatment and control = 19 fruits.

Significant difference between any two treatments = 23 fruits.

The mean yields per plot for the 12 treatments were as follows :—

	Treatment.	Mean yield in number of fruits.
(1)	½ ton lime	7½
(2)	½ ton lime, Sulphate of Ammonia 100, Superphosphate 300, Sulphate of Potash 100	38
(3)	As (2) + Magnesium Sulphate 240	36
(4)	Control	8
(5)	Superphosphate 300, Sulphate of Ammonia 100, Sulphate of Potash 100	46
(6)	As (5) with double Sulphate of Potash	73
(7)	As (5) + Magnesium Sulphate 240	61
(8)	Superphosphate 300, Sulphate of Potash 100	28
(9)	Superphosphate 300, Sulphate of Ammonia 100	37
(10)	Sulphate of Ammonia 100, Sulphate of Potash 100	13½
(11)	Pineapple Refuse 10 tons	15
(12)	Cattle Manure 10 tons	35

* "*z*" Measure of the ratio of random variance and variance between treatments (and varieties) calculated as $\frac{1}{2} \log_e \frac{\text{Treatment Variance}}{\text{Random Variance}}$;

† "*t*" Measure of the observed difference between two treatments to the standard deviation.

From these figures of mean yield it will be seen that all treatments shewed significant increase over control except (1) Lime, (10) Sulphate of Potash, (11) Pineapple Refuse. All treatments which shewed significant increases over control were of higher order than $P = .05$ except (8).

The layout of the experiment was in three randomised blocks each treatment appearing twice in each block. Results further shewed some difference in fertility between blocks.

In the cultural experiment application of the "*t*" test shewed, for the usual standard of significance of $P = .05$:—

For significant increase of any treatment over control (unweeded) 53 fruits.

For significant increase between any two treatments 78 fruits.

The mean plot yields for each treatment were as follows :—

Treatment.	Mean Plot Yield.
(1) PABCO mulch	293
(2) Forked once yearly	37
(3) Clean weeded	72
(4) Pineapple mulch	128
(5) Unweeded (as control)	15

From these figures it will be seen that PABCO mulch was highly significant over all other treatments. Pineapple mulch was significant over treatments 2 and 5 while clean weeded shews significance over unweeded.

BLEACHING OF PALM OIL AT SERDANG,

BY

C. D. V. Georgi,

Acting Agricultural Chemist

and

T. D. Marsh,

Assistant Agriculturist.

Introductory.

The present article gives an account of some additional experiments carried out on a semi-commercial scale in the oil palm factory at the Government Experimental Plantation, Serdang regarding the bleaching of palm oil, to which reference was made in a previous number of this Journal.*

In that article an account was given of the various methods employed for bleaching the oil, attention being drawn specially to the possibilities of air-bleaching with a catalyst, for example, cobalt borate.

Using this catalyst the experiments at Serdang have shown the possibility of the production of a bleached palm oil of good quality without the installation of an expensive plant.

Description of Plant.

A small iron tank, having a working capacity of approximately 1200 lbs. of oil, has been installed close to the De Laval separator. The tank is fixed at such a height that the oil after treatment can be discharged by gravity to the separator.

The tank is provided with a closed steam coil for heating the oil, also with a perforated pipe through which air from a blower can be injected into the heated oil. The blower is actuated by means of a small electric motor.

A supply tank, which can be filled from the De Laval separator, is fixed below the bleaching tank, the oil being raised by means of a hand-pump. The supply tank is calibrated, so that the amount of oil pumped into the bleaching tank can be calculated.

Description of Process.

The purified oil from the De Laval separator is pumped into the bleaching tank and the oil heated to a temperature of 90°C. Air is injected into the oil, the rate being adjusted so that the contents of the tank are maintained in a gentle state of agitation.

Owing to the air not being heated the temperature tends to fall a few degrees, and the steam supply is therefore increased slightly in order to maintain the oil at the required temperature.

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* *Malayan Agricultural Journal,* Vol. XXI, No. 1, January 1933.

Cobalt borate is added to the oil in the proportion of 20 grammes (approximately $\frac{3}{4}$ ounce) to every 400 lbs. of oil in the tank. The cobalt borate should be finely powdered and dusted over the surface of the oil.

As regards the colour of the oil, little change will be observed during the first hour, the colour becomes, however, distinctly lighter towards the end of the second hour. It is at this stage that the change in colour must be carefully followed, experience having shown that the change is rapid and it is easy to carry the process too far, with the result that the oil loses its bright appearance and is apt to develop a dull greyish tint.

A satisfactory method of judging the change in colour consists in withdrawing at regular intervals, every 10 minutes, a small amount of oil, placing it in a thin glass test-tube and cooling the latter in iced water. Under such conditions the oil solidifies, and by taking a series of samples the change in colour from yellow to the faint yellowish-white tinge, which represents the optimum colour of the bleached product, through to the greyish tinge can be easily traced. The time required is approximately 2½ hours.

Since a small amount of flocculent matter separates out in the oil as a result of the treatment the bleached oil is therefore allowed to cool slightly and passed through the De Laval separator in order to free the oil from any matter in suspension.

It does not appear feasible to attempt to recover the catalyst.

General.

Supplies of cobalt borate are not available in Malaya, and the catalyst must be ordered from manufacturing chemists in England. Among these firms may be mentioned The British Drug Houses Ltd., City Road, London, N. 1.

As far as can be ascertained the price of cobalt borate would be approximately $5 (Straits currency) per lb. Although the price may seem high it must be remembered that 1 lb. of the catalyst is sufficient to bleach 24 barrels of oil, so that the cost of catalyst per barrel is only approximately 20 cents.

While the method is not complicated, it must be emphasised that, if regular results are to be obtained, the conditions of bleaching must be maintained constant.

Previous experiments showed that the period of bleaching varied with the temperature and the amount of air. If, however, a series of tests is conducted as indicated above and the period for the complete bleaching effect noted, then by maintaining the same conditions it should be easy to regulate the process so as to ensure a standard product.

As far as can be judged, the bleaching effect is permanent, the colour showing no tendency to return even after the oil has been stored for more than one year.

In conclusion, it may be mentioned that demonstrations of the process will be given on application to the Senior Assistant Agriculturist, Government Experimental Plantation, Serdang.

Reviews.

The Valuation of Tuba Root

BY

C. D. V. Georgi, o.b.e., b.sc., f.i.c. and Gunn Lay Teik, b.a.

Department of Agriculture, S.S. and F.M.S.

Special Bulletin, Scientific Series No. 12, 30 pp. 1933.

Price 50 cents (Straits).

The increased interest being taken in tuba root for insecticidal purposes and the lack of any marked features by which the roots can be distinguished render chemical valuation desirable, at any rate until further information is available regarding both the optimum conditions of cultivation and harvesting for the different species of *Derris*.

In the publication just issued the authors point out that, while in the case of consignments for export the analysis of the roots is gradually becoming the usual practice, the results of the analysis are not apparently used as the basis on which the product is valued.

At present there are two standards on which the roots are sold, *i.e.* the amount of matter extractable by a solvent, usually ether, and the rotenone content. Rotenone is one of the specific toxic compounds known to be present in the roots. The solvent extract determination is usually required in the case of the roots exported to Europe, while the rotenone content is the basis for roots shipped to the United States of America.

Full details are given of the methods of analysis for both the amount of solvent extract and of the rotenone content. While the determination of the solvent extract offers no difficulties, the method for the estimation of rotenone is undoubtedly only approximate. It should not be difficult, however, to decide upon a standard procedure which would be acceptable to all concerned.

Under such conditions, it would seem only reasonable that the results of analysis should be used as the basis of valuation, a standard price being paid for roots containing definite amounts of either solvent extract or rotenone with a fixed rate of premium or discount according to whether the amount shown by chemical analysis is greater or less than the specified figure.

(A. T.)

Tapioca in Malaya

BY

V. R. Greenstreet, F.I.C., and J. Lambourne.

General Series: Bulletin No. 13: Department of Agriculture, S.S. and F.M.S. 76 pp. 24 plates: price $1 (Straits).

This Bulletin should prove to be a welcome addition to existing literature on the tapioca industry since it presents in its 76 pages a comprehensive account of the present condition of the industry in Malaya along with up to date information relating to progress achieved as a result of experimental work conducted by the authors and the staff of the Department of Agriculture in Malaya.

Tapioca has always been regarded in Malaya as a crop which is exceedingly exhausting to the soil in which it is grown. In fact a ruling made in the year 1927, allowing the cultivation of not more than two crops of tapioca on land alienated for rubber or other form of permanent cultivation, is still in force. It is pointed out, however, in the Bulletin under review, that the ill reputation which tapioca has borne and still bears, is in reality due to the manner in which the crop is cultivated, and it is stated that "once the necessity for rational methods of cultivation and manuring in relation to it are realised, there is no reason why the crop should not be grown continuously, or preferably in rotation with other crops, for an indefinite period on the same land not only without harm but probably with actual benefit to the soil by reason of the deeper and more thorough tillage which its cultivation necessitates".

The Bulletin, which is profusely illustrated, is divided into Chapters under the following headings:—Historical, Botanical, Cultivation, Soil Impoverishment and Manuring, Diseases and Pests, Tapioca Products and their Manufacture, Cost of Production, Tapioca Products and their Uses, Trade.

A useful key to the classification of the different varieties is included in the Botanical section, where also the important question of the prussic acid content of the varieties is discussed.

In the section devoted to manufacture of the tapioca products produced in Malaya *i.e.* tapioca flake, pearl, starch (flour) and refuse, a full account is given of the methods employed locally. It is shown that the average Malayan grades of edible tapioca compare unfavourably with those produced in Java where the industry is on a far larger scale than in Malaya.

(W. G. H.)

Observations on a Lac Insect (*Laccifer javanus* Chamb.) and an Account of Attempts to Propagate it.

BY

N. C. E. Miller, F.R.E.S.

Lac in Malaya, Part 1, 3 pls. Special Bulletin, Department of Agriculture, S.S. and F.M.S., Scientific Series, No. 11, 1933.
Price 50 cents (Straits).

This paper contains descriptions of a lac producing insect—*Laccifer javanus* Chamb., and also reports, *in extenso*, received from the Imperial Institute, London, on the quality of the lac and its market possibilities.

The insect in its various stages, its parasites and certain other insects associated with it are figured, and an account of attempts to propagate it on a large scale in its natural habitat on its original host tree *Macaranga megalophylla* M.A. are described.

The attempts at propagation, owing to many opposing factors among which the most important are parasites, were unsuccessful. It is intimated that, as there are possibilities that the species (*Tachardia lacca* Kerr.), which has been cultivated in India for many years, might adapt itself to local conditions it is intended to import sufficient brood lac for experimental purposes.

Investigations on *T. lacca* will, it is hoped, be published later as Part II of "Lac in Malaya".

(W. G. H.)

Abstracts.

FIFTEENTH REPORT ON NATIVE RUBBER CULTIVATION.

2nd Quarter 1933.

Prepared by the Bureau of Agricultural Economics of the Division of Agriculture of the Netherland Indian Department of Agriculture, Industry and Commerce, at Buitenzorg, August, 30th, 1933.

General review.

The prices, which during the second half of March fluctuated at an even level, increased regularly during the second quarter of 1933; the Batavia quotations rose from 6½ florin cents per ½ kilogram of Java Standard sheet in March to 12⅛ florin cents in the first week of June. After a drop to 9⅞ florin cents on June 17, prices rose again to 14 florin cents in July.

Causes for the increase in prices during April included the firmer tone on the American produce market, the persistent reports concerning a new attempt for rubber restriction and the uncertainty in the American rate of exchange. The news relative to a controlled inflation, restriction rumours, the increase in American consumption and the preparations for the World Economic Conference made the higher prices last until about the middle of June, when prices weakened as a result of an unfavourable report from London regarding restriction. This temporary decline, however, was followed by a rather sudden rise again.

The export of native rubber from Netherland India reacted sharply to the rising prices with the result that the drop in monthly exports, noted since November, 1932, came to a halt with the trend in exports showing a striking increase. During the first quarter of 1933 the exports of native rubber totalled 13,420 metric tons of dry rubber. In the second quarter, however, the export amounted to fully 25,417 metric tons, which total was not reached during any quarter of 1931 or 1932.

When calculated over a whole year the high July export of native rubber from Netherland India works out at an annual export of about 150,000 metric tons. It should be noted, however, that this total remains far behind potential production which for 1933 may conservatively be estimated at 300,000 metric tons.

As might be expected, the reaction of the prices on production in the native rubber cultivation in Netherland India was greatest in those areas where production dropped off most sharply during 1931 and 1932. The reaction was less noticed in those areas where production has been maintained due to the necessity of the native population to keep to rubber due to the lack of other means of livelihood. In this connection, attention may be drawn to the fact that in Djambi and in the Western Division of Borneo, although production was

decidedly affected, the increase in production was relatively less than in Palembang, in the Southern and Eastern Division of Borneo, and elsewhere.

The rubber remilling industry in both divisions of Borneo showed a greater degree of activity; the export of dry rubber from the Western Division of Borneo increased from 1,037 metric tons during the first quarter of 1933 to 1,515 metric tons during the second quarter. For the Southern and Eastern Division of Borneo the respective figures were 960 and 1,348 metric tons. In Tapanoeli, the production of blanket rubber increased from 70 to 175 metric tons. There are no reports covering rubber remilling activities in other areas.

Reports from various producing areas.

Acheen and Dependencies.

The higher prices during the second quarter caused a larger export. Prices at Langsa for wet slabs showed the following trends, prices being shown in florins per 100 kilograms:

Prices at Langsa in florins per 100 kilograms.

April 8, 1933	...	...	Fl.	3.00	—	Fl.	3.70
April 22, 1933	...	...	„	3.00	—	„	3.70
May 6, 1933	...	...	„	4.60	—	„	5.00
May 20, 1933	...	...	„	4.60	—	„	5.80
June 8, 1933	...	...	„	8.30	—	„	10.00
June 24, 1933	...	...	„	6.60	—	„	8.30

In spite of the higher prices, the production of rubber still remains a secondary occupation, even in the leading producing centres. Although in June tapping was again taken up in the gardens near Langsa as well as in deserted plantings in other areas, it is estimated that only about 10% of the total tappable area is under regular production.

Tapanoeli.

The export from Sibolga during the 1933 second quarter totalled 261 metric tons of dry rubber, consisting partly of sheety crepe, of the "sam-sam" or mixed qualities, and partly of blankets. Rubber from Padang Sidempoean and Kota Nopan is also shipped via the West Coast of Sumatra to Pakan Baroe. The amount of rubber shipped in this manner is not known exactly although it is in important amounts. During the second quarter in Tapanoeli a total of 175 metric tons of blankets were prepared against 70 metric tons in the first quarter.

The price on the Sibolga market in April amounted to 6½ florin cents per kilogram; it was as high as to 15 florin cents on June 26.

Tapping was resumed in the gardens located in favorable situations but the upkeep of the gardens is still not receiving much attention.

Sumatra West Coast.

The export from Padang totalled 2 metric tons; Bangkinang exported 271 metric tons via Pakan Baroe and Batang Hari and Sidjoendjoeng exported 185 metric tons via Djambi; the export from Loeboek Sikaping and from the Ophir districts via Sumatra East Coast Province is not known.

In addition to the price increase, in the subdivision of Bankinang, where tapping activities were increased by more than three times, it is reported that the low rice stocks also caused rubber production to be greater.

In this district also does the rubber cultivation remain of small significance in the native economy. It still represents an enterprise of secondary importance, the production of foodstuffs being considered much more important. Higher rubber prices will undoubtedly cause the native producers to again regard rubber as being more important than at present.

Palembang.

Calculated on a dry rubber basis, the exports of rubber from Palembang during the second quarter totalled 2,200 metric tons against 1,300 metric tons during the 1933 first quarter. The increase in exports is shown more clearly by the monthly export figures, as follows: 560 metric tons in April; 739 metric tons in May; 929 metric tons in June and 1,700 metric tons in July.

The number of tappers increased appreciably and more than doubled during the six week period from mid-May to the end of June. The area in tap was enlarged upstream by means of which the gardens most favourably located were taken into tap first.

The increase in production is entirely due to the rise in prices. Locally, speculation caused prices to rise even above the Singapore parity. Thus, for example, in the Lematang "margas" ("margas" equivalent to a collection of villages) the price increased to Fl. 10.00 per 100 kilograms of slabs by June 17 after which a decline took place to Fl. 7.00 in sympathy with a drop in prices in Singapore of 2 1/16 cents per kilogram; in general after the second week in June a price of Fl. 7.00 per kilogram was paid.

Djambi.

The export during the 1933 second quarter totalled 5,200 metric tons of dry rubber against 3,800 metric tons during the 1933 first quarter. The monthly export figures, show a decided reaction as a result of the rise in prices; this is not as strong, however, as in other regions since the monthly exports from Djambi have been large even with low prices prevailing. The export for July is about 2,400 metric tons (dry).

In May, according to a report received from the Resident, not more than 10% to 20% of the total planted area, which is estimated to include more than 260,000,000 trees, was in tap. Of the total planted area, it is reported that at the present time about half of the trees are of tappable age and that next year about two-thirds will be of tappable age.

Western Division of Borneo.

The export, calculated in terms of dry rubber, increased from 4,048 metric tons during the 1933 first quarter to 7,611 metric tons during the 1933 second quarter. The monthly export figures were as follows: April — 1,662 metric tons; May — 2,823 metric tons; June — 3,126 metric tons; and July — about 2,900 metric tons. The rubber remilling industry showed greater activity; the

export of dry rubber was increased from 1,037 metric tons during the 1933 first quarter to 1,515 metric tons during the 1933 second quarter.

The price increase was naturally the prime reason for the larger export. This was not the only reason, however, since many labourers were available because the rice harvest had been completed. A dry period also helped the native producers to tap rubber more expeditiously.

Southern and Eastern Division of Borneo.

The export from this division during the second quarter of 1933 was three and one-half times as great as during the first quarter of 1933. Monthly exports for the first seven months of the year were as follows: January — 647 metric tons; February — 498 metric tons; March — 619 metric tons; April — 955 metric tons; May — 2,344 metric tons; June — 3,080 metric tons; and July about 3,300 metric tons. This very appreciable increase in exports is due to the fact that the greater part of the rubber cultivation in the Southern and Eastern Division of Borneo is concentrated in the thickly populated Oeloe Soengei district and so the necessary labour forces could be secured without difficulty.

The export of dry native rubber increased from 960 metric tons during the 1933 first quarter to 1,348 metric tons during the 1933 second quarter. During June, two remilling plants, with a combined capacity of 550 metric tons a year, were put back into operation. The Nomura company, during the second quarter, bought up 222.5 metric tons of dry native rubber, about three times the amount bought up during the 1933 first quarter.

The total amount of business done at Amoentai during the 1933 second quarter involved 2,611 metric tons against only 180 metric tons during the 1933 first quarter. The local Netherland India officer in the subdivision of Barabai reported that tapping during May reached a point not even reached during the "Hausse" or boom times. Even so, it is reported that fully two-thirds of the areas are not being tapped and an important part of these areas has never yet been tapped.

Riouw and Dependencies.

The monthly export from inside the Netherland Indian customs territory of this district was as follows during the first half of 1933: January — 502 metric tons; February — 355 metric tons; March — 394 metric tons; April — 391 metric tons; May — 729 metric tons; June — 840 metric tons; and July — 807 metric tons. These figures show a quick increase beginning with May.

P.S.—The rubber export figures in August, received by telegraph from the principal ports, show a decrease in exports of native rubber in the month of August. They may be estimated at about 11,400 metric tons (12,700 tons in July). Causes for this decrease may be found in the declining prices since July, but also in the speculative character of rubber trade, through which price movements in the interior are accentuated; also possible increasing stocks, in the hope of recovering prices, might have been of influence.

TEA PROPAGANDA BY CARAVAN IN CEYLON.

The following extract, which is taken from the Planters Journal and Agriculturist, August 1st 1933, is published for the information of those interested in the work of the Rural Lecture Caravan in Malaya.

"The Ceylon Tea Propaganda Board recently took delivery in Colombo of a motor caravan which, handsomely appointed with every conceivable accessory, will tour the roads of Ceylon, her crew of eight spreading tea propaganda to the populace. The caravan is constructed on a Commer Raider chassis and built locally by Rowland's Garage in Colombo. A tent, attached to the hood, when erected provides sleeping accommodation for four, the folding beds being carried in the caravan. The caravan carries—for use in the Tea Propaganda—60 cups and saucers, kettles, teapots, 300 lbs. of tea in packets, 3 stoves, 4 portable tables, 7 chairs, trays, banners, banner-holders and megaphones. These last, aided by an 8-valve wireless set fitted with a loudspeaker and microphone, and 2 gramophones, will be of the greatest help to the propaganda crew when addressing large crowds. The roof signboard bears on one side Sinhalese, and on the other, Tamil characters to the effect "Drink good Ceylon Tea." It is floodlit at night. In travelling trim with a full load and crew aboard the caravan weighs 3½ tons. Its water tank has a capacity for 60 gallons, and 30 gallons of petrol may be carried. Seven electric batteries and two dynamos provide the current necessary for lighting brightly the interior of the caravan. The caravan is very compact and seems to be entirely independent as to where it camps or moves about. It will be of immense value to the propaganda Board in their local Tea advertising campaign and should have the desired effect of increasing local tea sales. It is understood that this is the first of a fleet of similar caravans to be put into use later on."

Departmental.

FROM THE DISTRICTS.

The Weather.

In most parts of the Peninsula the rainfall for the month was below average, the weather in general being hot and dry for the first three weeks with rain during the last week. In Province Wellesley and Selangor there were also showers during the first week of the month, while in South Kedah showers were more frequent and more evenly distributed.

In the meteorological area embracing the coast of the Negri Sembilan and the whole of Malacca Settlement the rainfall was heavier and normal for the month.

In Johore and Singapore the weather was hot and showery, though precipitation in Johore was on the whole below the average, especially in the Batu Pahat District.

No information from the East Coast is yet available.

Remarks on Crops

Rubber. There was a slight decline in the average price of rubber during the month. The highest and lowest prices in dollars and cents per picul recorded during the month for rubber from small holdings were :—Smoked Sheet $10 to $16; Unsmoked Sheet $7 to $15; Scrap $1.50 to $8. The average Singapore prices recorded for small-holders' rubber were :—Smoked Sheet $15; Unsmoked Sheet $14; Scrap $5.50, as compared with $15, $14 and $6 in August. The Penang prices for Unsmoked Sheet ranged from $11.50 to $13.50 against $13 to $15.50 in August.

In spite of the slight further decline the present price of rubber appears to be remunerative to small-holders, since there has been a further increase in the number of holdings tapped in almost all parts of the Peninsula.

In other respects the situation remains the same as in August. The control of Mouldy Rot disease continues to receive attention and there has been a wider distribution and increased use of the approved disinfectants.

Padi. The price of padi at the Government Rice Mill, Bagan Serai was $1.70 per picul as compared with $1.80 in August. In Kedah, however, the price rose somewhat varying from $10.50 to $16 per kuncha (160 gantangs). These prices are equivalent to 7 and 6½ to 10 cents per gantang respectively. In some districts where little padi is grown the price was as high as 12 cents per gantang.

Padi planting has progressed well in Kedah, Province Wellesley and Krian. In some parts of Perak planting has been delayed by drought and areas already planted have suffered from lack of water. Drought has also delayed planting in Kuala Selangor District. In the Negri Sembilan preparation of the land and planting made better progress in Kuala Pilah District and in the coastal area of Malacca more favourable weather enabled planting operations to be nearly completed.

In the inland districts of Selangor harvesting of the short-term padi was in progress and on the whole good crops were being obtained.

In Johore padi planting takes place at very different times even in the same locality and the mixed strains of padi used vary much in their maturation period. Consequently, ripening is very uneven and the crop suffers severely from the ravages of birds, as has been experienced during the harvest now in progress in Batu Pahat District.

Coconuts and Copra. There has been a further considerable decline in the price of copra, prices in various centres during the month ranging from $2 to $3.60 per picul, with Penang prices $2.80 to $3.30 and the average Singapore price $2.75 per picul.

Inspite of the low price the interest of Malays in the production of improved copra has been well sustained. A new kiln has been built on approved lines at Alor Star, Kedah. Apart from this there is little to add to the review of the position given last month.

A small group of palms in the Sungei Star area in Krian was attacked by the Zygaenid, *Artona catoxantha*; the control measures recommended were carried out and the attack ceased.

Fruit. Rambai were fruiting heavily at Kampong Paoh in Larut District. In the mukims of Budu and Tanjong Besar in Kuala Lipis District of Pahang fairly good crops, more especially of langsat, were harvested. For about two weeks between 4 and 6 lorry loads were sent to Kuala Lumpur daily. In Johore Duku and Rambai were still in season. Elsewhere the fruit season had terminated.

There is a flourishing banana industry in the Batu Pahat District of Johore. It is estimated that some 50 tons of bananas are sent by lorry to Singapore each week. The varieties sent are cooking bananas and the eating variety known as Pisang Masak Hijau. The growers are mostly Javanese.

Tobacco. Prices for dried tobacco leaves ranged from $20 to $45. and showed a slight decline. The planted area is being extended in Baling District of Kedah, Kinta District of Perak, where in one locality alone some 500 acres are planted, in Raub District of Pahang and in the Serangoon area of Singapore. In the Batu Pahat District of Johore large quantities of leaf were being harvested and good samples of prepared yellow leaf grown and cured by Javanese were to be seen in several places.

Agricultural Stations.

At all Stations good progress has been made in the planting up or supplying of plots of permanent crops such as tea, coffee, fruit trees, cloves and nutmegs; a number of plots of temporary crops have also been planted. Plots of vegetables and annual crops have been reaped; much of this produce will be distributed as planting material to School Gardens. The tobacco harvest was in progress at the Kuala Kangsar and Temerloh Stations and satisfactory crops were being obtained. At the Pineapple Experiment Station in Singapore trials of vegetative methods of reproducing fruit trees known to be of good quality were in progress. These included planting cuttings, marcotting, budding and the use of the etiolation method. It is becoming necessary to build up an adequate stock of young fruit trees of good quality at this Station which already has to meet a growing demand for such planting material.

It is reported that good progress has been made in the establishment of the combined Agricultural Station and Padi Test Plot at Brunei. Pending the arrival of Malay officers now in training at the School of Agriculture, Serdang, the District Officer is supervising the work on this Station with the advice and assistance of the Agricultural Field Officer, Singapore, who visited Brunei in August and took with him supplies of planting material for this Station.

Padi Stations and Test Plots.

Work on these Stations and Plots continued normally. Planting was completed at the Telok Chengai Station in Kedah and at Pulau Gadong Station and the Padi area at Sungei Udang Station in Malacca. Reaping was commenced on the Kajang and Kuang Padi Test Plots in Selangor. On the former Plot satisfactory yields were obtained from Radin Siak, F.S. 27, F.S. 756, Padi Kelantan and Padi Acheh, but on the Kuang Plot yields from the same strains and varieties appeared to be low. Radin Siak suffered severely from the ravages of birds which appear to be especially partial to this strain.

School and Home Gardens.

The half yearly classification of School Gardens in Penang and Province Wellesley was held on August 28th to 30th, judging being done by the Agricultural Field Officer, the Malay Assistant Inspector of Schools and the Malay Agricultural Assistant in each district. As a result seventeen schools obtained between 80 and 100 marks, thirteen between 70 and 80 marks and seven between 60 and 70 marks. The highest marks were obtained by Sungei Nibong School with $94\frac{2}{3}$ and Bayan Lepas with 92.

A large number of home gardens have been made by school children in Selangor, mainly as a result of District competitions. These competitions not only encourage the planting of vegetables in small holdings belonging to the parents but, if the gardens are well kept, have a considerable effect on the whole population of the village.

Many of the gardens reach a high standard of excellence and are a credit to their owners and the advisory officers.

General.

Carp Rearing. A Malay at Budu in the Kuala Lipis District of Pahang started an experiment in carp rearing towards the end of 1932. The fish with which he was then supplied have reached a weight of 2 — 2½ katies and are doing extremely well. The owner of these two ponds is extending his operations and another Malay in the same district has asked for 2,000 fry. Enquiries have also been received from two sources in Raub. This is a minor industry which might well be more widely adopted by Malays in localities where supplies of fish are difficult to obtain.

Kelantan Match Factory.

The Acting British Adviser, Kelantan, has provided the information that this factory is making match sticks prepared from the wood of rubber trees thinned out from rubber estates. This rubber wood gives a fairly satisfactory match stick, but is considerably harder to cut than either the local or Japanese timber usually employed for this purpose.

DEPARTMENTAL NOTES.

Visits and Tours.

The Director of Agriculture, Dr. H. A. Tempany, C.B.E., paid a visit to Fraser's Hill from September 9th to 11th and inspected the Dairy and Poultry Farm. He also visited Cameron Highlands from September 28th to 30th, discussed agricultural matters with the officer-in-charge of the Experiment Station, Tanah Rata, and made a tour of some of the recently opened areas in the Highlands.

Mr. A. Thompson, Acting Govt. Mycologist, visited Cameron Highlands from September 17th—20th in connection with diseases of certain crops in this region.

Major C. D. V. Georgi, O.B.E., Acting Agricultural Chemist, visited an Oil palm estate in Negri Sembilan, to give advice on problems connected with factory practice.

The Director, accompanied by Mr. F. W. South, Chief Field Officer, Mr. R. B. Jagoe, Acting Economic Botanist, Mr. J. A. Simpson, Agricultural Field Officer, Selangor, and Mr. W. H. Barnes, Poultry Instructor, visited Kajang District Agricultural Show, on October 1st.

Malayan Pinepple Industry.

The Director addressed the Kuala Lumpur Rotary Club on the subject of the Malayan Pineapple Industry on September 6th.

Staff Charges and Leave.

Mr. F. W. South, Chief Field Officer, returned from leave and resumed duty on 2nd September, 1933.

Mr. F. Birkinshaw, Acting Chief Field Officer, returned to Taiping and resumed duty as Senior Agricultural Officer, Perak, on September 11th.

Mr. F. R. Mason, Agricultural Field Officer, has been seconded for service under the Government of Johore as Acting Principal Agricultural Officer, with effect from 13th September 1933.

Mr. A. E. Colman Doscas returned from leave and assumed duty as Agricultural Field Officer, Negri Sembilan, on September 2nd.

Mr. J. Fairweather, Principal Agricultural Officer, Johore, has been granted full pay leave of 8 months and 7 days from September 15th.

Mr. R. G. H. Wilshaw, Agricultural Field Officer, has been granted full pay leave of 7 months and 24 days from September 2nd.

Statistical.

MARKET PRICES

September 1933.

Rubber.—The market price was fairly steady during the month, opening at 12 3/16 cents per lb. for Spot loose in Singapore and closing at 12 6/16 cents per lb. The average price for the month was 11 15/16 cents per lb. in Singapore, 3 11/16 pence in London and 7 cents Gold in New York as compared with 12 3/16 cents, 3 13/16 pence and 7⅛ cents Gold respectively in August.

Palm Oil.—The course of the English market during September on a basis of 18 per cent., f.f.a., c.i.f. Liverpool was as follows:—September 1st £16.15.0 per ton, market quiet, September 8th £16.10.0 per ton, market dull, September 14th £16.10.0 per ton market steady and September 28th £15.15.0 per ton market easy.

Prices in the U.S.A. landed weight per pound in bulk c.i.f. New York/Philadelphia were 3.40 cents Gold on the 9th September; 3.25 cents Gold on the 16th September; 3.30 cents Gold on the 23rd September and 3.20 cents Gold on the 30th September.

The price of palm kernels Fair Average Malayan Quality c.i.f. landed weight on the Continent was Shillings 8/1½ per cwt. on the 9th September; Shillings 7/7½ on the 16th; Shillings 8/- per cwt. on the 23rd, and Shillings 8/- per cwt. on the 30th September.

Copra.—There has been a slight fall in price during the month. The highest Singapore price for Sundried during September was $3.55 per picul, and the lowest price $3.30 per picul, the average price being $3.42 per picul as compared with $3.70 per picul during August.

The mixed quality averaged $2.87 per picul as compared with $3.13 in August.

Coffee.—The price at Singapore for Sourabaya coffee was steady and was similar to ruling prices in August. Prices ranged according to grade, from $17.50 to $19.50 as compared with $16 to $19 during August. Palembang coffee averaged $12.75 during the month being quoted at $12.50 on the 1st and $12.50 on the 29th the average figure for September was $12.75.

Arecanuts.—Palembang's averaged $2.27 and Bila Whole $2.15 per picul as compared with $2.49 and $2.37 during August. The range of Singapore prices for other grades was:—Split $2.25 to $4; Red Whole $3 to $4.50. Sliced $10 to $12.50, and Kelantan $2.50 to $3.50.

Gambier.—There was a slight fall in price of Block Gambier during September, the average price being $4.50 per picul, Cube No. 1 averaged $7.50. Corresponding figures for August were:—$4.75 and $8 respectively.

Pineapples.—Values again firmed slightly during September, the average Singapore price per case being: Cubes $3.30, Sliced Flat $3.30 and Sliced Tall $3.30 as compared with $3.26, $3.16, and $3.25 during August.

Tapioca.—The price of Flake Fair averaged $4 as compared with $3.95 in August. Pearl Seed averaged $5, the average being similar in August, and Pearl Medium averaged $5 the average price being similar in the previous month.

Sago.—Pearl—Small fair fell in price to $4 during the month, Flour-Sarawak fair averaged $1.77 as compared with $1.83 in August.

Mace.—Prices ruling during the month were similar to August prices, namely $70 per picul for Siouw and $50 for Amboina.

Nutmegs.—Prices were steady during the month. Singapore price per picul for 110's was $20 a similar price was obtained during August, and 80's averaged $26 having averaged $26.50 in the previous month.

Pepper.—Average Singapore prices during September were as follows:—Singapore Black $13.12 per picul; Singapore White $21.94 and Muntok White $22.56, the corresponding figures for July were $13.19, $23.12, and $23.75 respectively.

Cloves.—As previously, the demand for cloves remains small, nominal prices being $40 for Zanzibar and $45 per picul for Amboina.

GENERAL RICE SUMMARY.

August 1933.

Malaya.—Gross foreign imports of rice (including stocks available for re-export) during August 1933, amounted to 57,930 tons, as compared with 47,430 tons in August 1932, of which 46 per cent. were consigned to Singapore, 18 per cent. to Penang, 9 per cent. to Malacca, 21 per cent. to the Federated Malay States and 6 per cent. to the Unfederated Malay States.

Of these imports, 58 per cent. were from Siam, 40 per cent. from Burma, 1 per cent. from Indo-China and 1 per cent. from other countries.

Total foreign exports of rice from Malaya in August 1933, were 14,717 tons (including 334 tons local production) as compared with 15,861 tons in August 1932.

Of these exports 78 per cent. were consigned to Netherlands India and 22 per cent. to other countries.

Net imports for the period January to August 1933, were 281,279 tons as compared with 267,135 tons during the same period for 1932, a rise of 5.3 per cent.

India and Burma.—Total foreign exports of rice during July 1933, were 131,000 tons as compared with 221,000 tons in the previous month and 119,000 tons in July 1932.

Japan.—The position from August 1st, to the end of October, is estimated as follows :—

Supply	Tons	Tons
Stocks on August 1st	3,110,000	
Imports from Korea	180,000	
.. .. Formosa ...	199,000	
.. .. Other Countries ...	43,000	3,532,000

Siam.—Exports (approximate) during August 1933, amounted to 142,346 tons as compared with 136,575 tons in August 1932.

The area under padi for season 1932—1933 in 60 Provinces amounted to 8,034,476 acres, an increase of 307,502 acres or 4 per cent. as compared with the same period of 1932.

The area damaged is estimated at 505,964 acres, a decrease of 767,970 acres or 60 per cent. from that of the previous year.

Netherlands India, Java and Madura.—For the period end of July 1933, the area harvested amounted to 7,658,000 acres a decrease of 96,000 acres or 1 per cent. as compared with the corresponding period of 1932: the area damaged was 398,000 acres an increase of 90,000 acres or 29 per cent. as compared with 1932, and additional plantings awaiting harvesting amounted to 1,578,000 acres

an increase of 271,000 acres or 21 per cent. The total acreage at the end of August 1933, amounted to 9,634,000 acres, an increase of 265,000 acres or 3 per cent. as compared with the same period in 1932.

French Indo-China.—Entries of padi at the port of Cholon from January to August 1933, amounted to 851,523 metric tons, an increase of 41,843 tons or 5 per cent. as compared with the same period of 1932.

Exports of rice from Saigon for the period January to August 1933 totalled 954,540 tons, an increase of 129,904 tons or 16 per cent. as compared with the corresponding period of 1932.

Ceylon.—Imports for the period January to July 1933, totalled 253,370 tons, a decrease of 12,309 tons on the imports for the same period of 1932.

Of these imports 20 per cent. were from British India, 80 per cent. from other countries.

Europe and America.—Quantities of rice shipped from the East were :—

(*a*) To Europe for the period January 1st to August 24th, 933,962 tons, an increase of 237,655 tons or 34 per cent. as compared with the same period of 1932. Of these shipments 52 per cent. were from Burma, 3 per cent. from Japan, 38 per cent. from Saigon, 6 per cent. from Siam and 1 per cent. from Bengal, as compared with 57 per cent. from Burma, Nil per cent. from Japan, 36 per cent. from Saigon, 4 per cent. from Siam and 3 per cent. from Bengal in 1932.

(*b*) To the Levant, period January 1st to August 3rd, 20,722 tons, a fall of 21,753 tons or 51 per cent. as compared with the same period of 1932.

(*c*) To America and the West Indies for the period January 1st to August 3rd, 99,765 tons an increase of 10,416 tons or 12 per cent. as compared with the same period of 1932.

MALAYA RUBBER STATISTICS

ACREAGES OF TAPPABLE RUBBER NOT TAPPED ON ESTATES OF 100 ACRES AND OVER, FOR THE MONTH ENDING AUGUST, 1933.

STATE OR TERRITORY	Acreage of Tappable Rubber end 1932	ESTATES WHICH HAVE ENTIRELY CEASED TAPPING		ESTATES WHICH HAVE PARTLY CEASED TAPPING		Total (3) + (5)	Percentage of (7) to (2)
		Acreage	Percentage of (3) to (2)	Acreage	Percentage of (5) to (2)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
STRAITS SETTLEMENTS :—							
Province Wellesley	44,734	1,447	3.2	8,028	17.9	9,475	21.1
Dindings	6,969	209	3.0	857	12.3	1,066	15.3
Malacca	111,780	5,315	4.7	20,325	18.2	25,640	22.9
Penang Island	1,635	626	38.3	255	15.6	881	53.9
Singapore Island	28,269	10,560	37.3	4,523	16.0	15,083	53.3
Total S.S. ...	193,387	18,157	9.4	33,988	17.6	52,145	27.0
FEDERATED MALAY STATES :—							
Perak	250,951	8,024	3.2	34,602	13.8	42,626	17.0
Selangor	308,379	9,566	3.1	42,422	13.7	51,988	16.8
Negri Sembilan	228,541	8,783	3.8	22,210	9.7	30,993	13.5
Pahang	38,141	6,145	16.1	5,339	14.0	11,484	30.1
Total F.M.S. ...	826,012	32,518	3.9	104,573	12.7	137,091	16.6
UNFEDERATED MALAY STATES :—							
Johore	325,747	28,383	8.7	36,075	11,1	64,458	19.8
Kedah (*a*)	114,551	5,254	4.6	8,984	7.8	14,238	12.4
Kelantan	21,175	6,715	31.7	2,591	12.2	9,306	43.0
Trengganu (*b*)	4,352	Nil	Nil	2,072	47.6	2,072	47.6
Perlis (*a*)	957	177	18.5	542	56.6	719	75.1
Total U.M.S. ...	466,782	40,529	8.7	50,264	10.8	90,793	19.5
TOTAL MALAYA ...	1,486,181	91,204	6.1	188,825	12.7	280,029	18.8

Notes :— (*a*) Registered companies only and are rendered quarterly.

(*b*) Registered companies only.

The above table together with a Summary, was prepared and published by the Statistics Department, S.S. and F.M.S. in September 1933.

MALAYAN AGRICULTURAL EXPORTS, AUGUST 1933.

PRODUCT.	NET EXPORT IN TONS.				
	Year 1932	Jan-Aug. 1932	Jan-Aug. 1933	August 1932	August 1933
Arecanuts ...	20,280	13,615	13,513	481	1,592
Coconuts, fresh† ...	108,123	83,244	68,066	8,972	8,530
Coconut Oil ...	11,932	7,322	11,759	1,225	1,252
Copra ...	97,464	55,185	60,545	12,469	13,919
Gambier, all kinds ...	2,925	2,103	1,637	330	276
Palm kernels ...	1,248	752	1,148	161	186
Palm oil ...	7,892	4,547	6,130	734	1,207
Pineapples canned ...	66,291	50,729	46,845	5,723	6,487
Rubber § ...	417,137	272,085	292,476	36,408	41,074
Sago,—flour ...	10,267	5,226	2,850	1,087	467*
„ —pearl ...	3,128	1,888	1,430	487	210
„ —raw ...	4,148*	2,696*	2,649*	264*	219*
Tapioca,—flake ...	9,028	6,325	7,239	1,049	570
„ —flour ...	392	190*	126*	69	2
„ —pearl ...	19,977	13,912	11,608	2,010	2,097
Tuba root ...	165½	83	313½	20	43

† hundred in number. § production. * net imports.

MALAYAN PRODUCTION IN TONS OF PALM OIL & KERNELS FIRST AND SECOND QUARTERS, 1933.

(As declared by Estates).

	Palm Oil		Palm Kernels	
	F.M.S.	Johore	F.M.S.	Johore
1933 January	502.0	129.0	94.6	20.4
February	550.4	155.6	112.5	27.0
March	756.5	208.4	130.6	33.2
Total 1st Quarter	1,808.9	493.0	337.7	80.6
1933 April	689.7	261.2	110.2	48.6
May	492.0	365.9	94.9	26.9
June	547.8	500.6	91.9	98.5
Total 2nd Quarter	1,729.5	1,127.7	297.0	174.0
Total 1st and 2nd Quarters ...	3,538.4	1,620.7	634.7	254.6

MALAYA RUBBER STATISTICS

TABLE I

STOCKS, PRODUCTION, IMPORTS AND EXPORTS OF RUBBER, INCLUDING LATEX, CONCENTRATED LATEX AND REVERTEX, FOR THE MONTH OF AUGUST, 1933 IN DRY TONS.

Territory	Stocks at beginning of month 1			Production by Estates of 100 acres and over		Production by Estates of less than 100 acres estimated 2		Imports during the month		Imports January to August 1933		Exports including re-exports during the month		Exports including re-exports January to August 1933		Stocks at end of month		
	Ports	Dealers	Estates of 100 acres and over	during the month	January to August 1933	during the month	January to August 1933	Foreign	From Malay States Labuan	Foreign	From Malay States Labuan	Foreign	Local	Foreign	Local	Ports	Dealers	Estates of 100 acres and over
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
MALAY STATES :—																		
Federated Malay States ...	...	12,103	11,669	11,927	88,497	10,111	69,823	Nil	Nil	Nil	Nil	16,409	4,371	112,187	48,962	...	13,270	11,744
Johore ...	...	2,999	2,937	3,946	28,562	4,461	34,498	Nil	76	Nil	99	1,884	6,288	10,467	52,447	...	3,211	3,036
Kedah ...	...	413	1,891	2,757	18,360	1,611	10,679	Nil	Nil	Nil	Nil	1,506	2,625	9,703	20,063	...	464	2,077
Perlis ...	...	14	11	7	59	21	87	Nil	Nil	Nil	Nil	Nil	27	Nil	165	...	15	11
Kelantan ...	...	501	180	240	1,379	547	4,220	Nil	Nil	330	Nil	83	855	599	5,081	...	331	199
Trengganu ...	...	55	50	147	1,004	74	501	Nil	Nil	Nil	Nil	Nil	221	Nil	1,505	..	55	50
Total Malay States	...	16,085	16,738	19,024	137,861	16,825	119,808	Nil	76	330	99	19,882	14,387	132,956	128,223	...	17,346	17,117
STRAITS SETTLEMENTS :-																		
Malacca ...	...	3,850	1,183	1,449	10,987	2,893	17,739	Nil	14,381	10	128,656	3,906	Nil	32,218	Nil	...	3,277	1,270
Province Wellesley	...	1,628	733	593	4,078			Nil		Nil						...	1,167	728
Dindings ...	...	31	124	110	773			Nil		Nil		6,926		50,513		...	28	138
Penang ...	1,147	4,948	8	11	30			991		5,133						1,362	5,521	12
Singapore ...	11,439	30,136	149	169	1,200			12,269		68,359		21,722		134,938		8,253	31,502	145
Total Straits Settlements	12,586	40,593	2,197	2,332	17,068	2,893	17,739	13,260	14,381	73,502	128,656	32,554	Nil	217,669	Nil	9,615	41,495	2,293
TOTAL MALAYA	12,586	56,678	18,935	21,356	154,929	19,718	137,547	13,260	14,457	73,832	128,755	52,436	14,387	350,625	128,223	9,615	58,841	19,410

TABLE II

DEALERS' STOCKS, IN DRY TONS 3

Class of Rubber	Federated Malay States	S'pore	Penang	Province We'sly D'dings M'cca.	Johore	Kedah
20	21	22	23	24	25	26
DRY RUBBER	9,867	25,181	4,978	4,256	1,510	157
WET RUBBER	3,403	6,321	543	216	1,701	307
TOTAL ...	13,270	31,502	5,521	4,472	3,211	464

TABLE III

FOREIGN EXPORTS

PORTS	For month	January to Aug. inc. 1933
Singapore ...	33,981	212,676
Penang ...	11,588	81,314
Port Swettenham.	6,464	48,765
Malacca ...	403	7,870
MALAYA ...	52,346	350,625

TABLE IV

DOMESTIC EXPORTS 4

AREA	For month	January to Aug. inc. 1933
Malay States ... / Straits Settlements	38,655	279,525
MALAYA ...	38,655	279,525

Notes :—1. Stocks on estates of less than 100 acres and stocks in transit on rail, road or local steamer are not ascertained.

2. The production of estates of less than 100 acres is estimated from the formula : Production + Imports + Stocks at beginning of month = Exports + Stocks at end of month. + Consumption, *i.e.*, Column [7] = Columns [13] + [14] + [17] + [18] + [19] + 16 tons local consumption during the month —[2]—[3]—[4]—[5]—[9]—[10]. For the Straits Settlements, Columns [9] and [10] represent purchases by dealers from local estates of less than 100 acres, reduced by 15 to terms of dry rubber.

3. Dealers' stocks in the Federated Malay States are reduced to dry weights by the following fixed ratios: unsmoked sheet, 15%; wet sheet, 25 %, scrap, lump, etc., 40%; stocks elsewhere are in dry weights as reported by the dealers themselves.

4. Domestic exports are estimated by deducting the average monthly dry weight of foreign imports over a period of 2 months from the gross foreign exports of the later month, the foreign exports of the Malay States being domestic production.

5 The above, with certain omissions, is the Report published by the Registrar-General of Statistics, S.S. and F.M.S., at Singapore on 24th August 1933.

METEOROLOGICAL SUMMARY, MALAYA, AUGUST, 1933.

Locality	Air Temperature in degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes						Total		Most in a day	Number of days					Total	Daily Mean	Per cent
	A. Max.	B. Min.	Mean of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot	At 4 feet			Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more			
	°F	°F	°F	°F	°F	°F	°F	°F	°F	in.	mm.	in.						hr.	hr.	%
Railway Hill, Kuala Lumpur, Selangor ...	90.2	71.7	80.9	94	70	86	74	83.9	84.7	7.70	195.6	1.76	17	16	8	6		209.15	6.75	55
Bukit Jeram, Selangor ...	88.3	72.3	80.3	92	70	85	75	84.2	86.0	3.89	98.8	1.08	16	11	3		1	232.20	7.49	61
Sitiawan, Perak ...	89.5	72.3	80.9	94	69	87	75	83.9	85.4	3.01	76.5	0.59	18	16	2			224.15	7.23	59
Kroh, Perak * ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Temerloh, Pahang ...	90.2	72.1	81.1	94	69	86	74	85.1	86.4	6.94	176.3	2.09	14	12		3		225.70	7.28	60
Kuala Lipis, Pahang ...	88.5	71.6	80.0	91	69	85	75	84.6	85.1	4.59	116.6	1.36	16	14		19		199.05	6.42	53
Kuala Pahang, Pahang ...	86.6	74.2	80.4	89	71	81	78	86.3	86.1	4.71	119.6	1.82	15	12			1	253.10	8.16	67
Mount Faber, Singapore ...	88.0	75.5	81.7	93	71	77	79	83.5	84.0	5.92	150.4	1.05	14	11	5			215.10	6.94	57
Butterworth, Province Wellesley ...	88.1	73.8	80.9	90	71	85	77	84.9	85.6	7.06	142.2	1.66	14	12	1			230.65	7.44	60
Bukit China, Malacca ...	85.0	73.8	79.4	87	71	82	77	83.8	84.4	7.30	185.4	2.59	16	13	2			241.45	7.79	64
Kluang, Johore ...	87.6	70.9	79.3	91	67	84	74	81.3	82.2	11.00	279.4	3.98	22	17	2	12		197.55	6.37	52
Bukit Lalang, Mersing, Johore	86.8	71.9	79.3	89	69	83	75	81.7	82.0	9.58	243.3	3.78	13	11	2	1	1	245.95	7.93	65
Alor Star, Kedah ...	87.9	74.3	81.1	91	71	84	77	86.0	86.1	7.21	183.1	1.21	17	16	10	1		219.60	7.08	58
Kota Bahru, Kelantan ...	89.7	73.8	81.7	93	72	87	76	85.0	85.4	4.18	106.2	1.24	11	8	1			238.75	7.70	63
Kuala Trengganu, Trengganu	88.5	73.0	80.7	91	70	82	76	83.9	84.8	1.20	30.5	0.39	8	5		2		235.40	7.59	62
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft. Pahang ...	74.6	62.8	68.7	80	61	71	65	71.2	71.8	8.95	227.3	1.52	21	18	1	5		184.35	5.95	49
Cameron Highlands, Tanah Rata, Pahang 4750 ft. ...	71.9	55.1	63.5	75	49	68	61	69.2	69.4	10.95	278.1	1.78	20	18	3	1	1	143.85	4.64	38
Cameron Highlands, Rhododendron Hill, Pahang 5120 ft. ...	71.1	59.4	65.3	75	58	66	62	—	—	12.21	310.1	1.75	20	18		1	1	146.25	4.72	38

Compiled from Returns supplied by the Meteorological Branch, Malaya.

* This Station has been dismantled.